NASA SP-7037 (292)
June 1993

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA STI PROGRAM
SCIENTIFIC & TECHNICAL INFORMATION

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National Aeronautics and Space Administration
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INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 675 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N93-22081 — N93-24658
International Aerospace Abstracts (IAA) (A-10000 Series)	A93-29781 — A93-33480

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

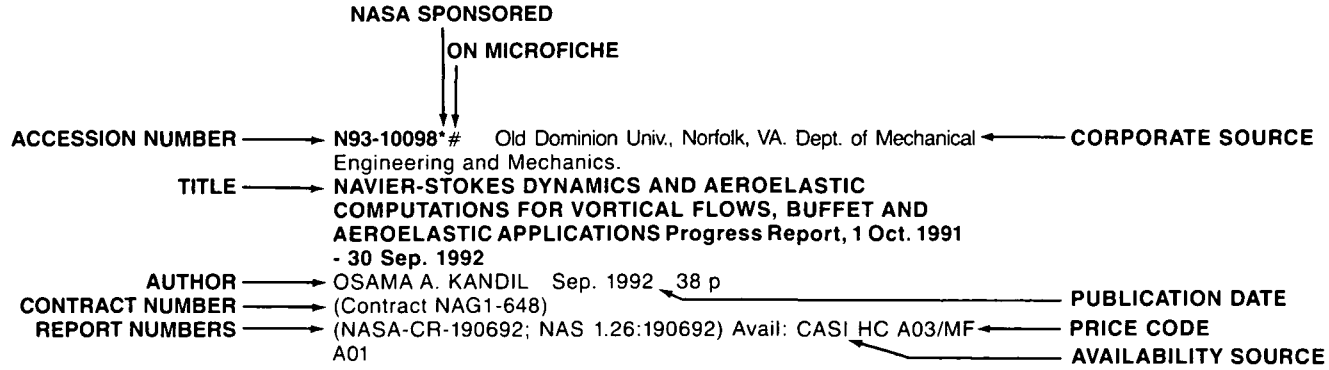
Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1993 will be published in early 1994.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

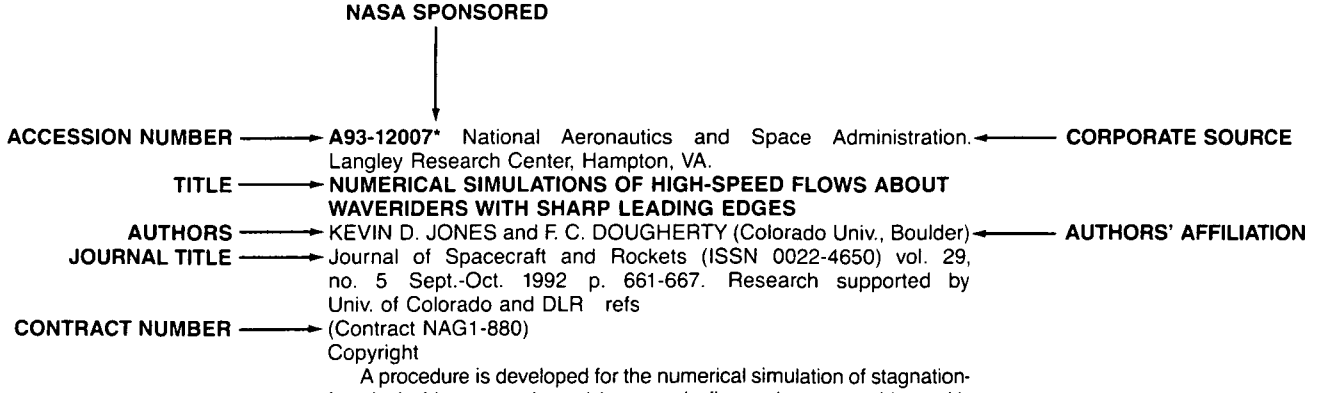
CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT



The accomplishments achieved during the period include conference and proceedings publications, journal papers, and abstracts which are either published, accepted for publication or under review. Conference presentations and NASA highlight publications are also included. Two of the conference proceedings publications are attached along with a Ph.D. dissertation abstract and table of contents. In the first publication, computational simulation of three-dimensional flows around a delta wing undergoing rock and roll-divergence motions is presented. In the second publication, the unsteady Euler equations and the Euler equations of rigid body motion, both written in the moving frame of reference, are sequetially solved to simulate the limit-cycle rock motion of slender delta wings. In the dissertation abstract, unsteady flows around rigid or flexible delta wings with and without oscillating leading-edge flaps are considered. L.R.R.

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



A procedure is developed for the numerical simulation of stagnation-free inviscid supersonic and hypersonic flows about waveriders with sharp leading edges. The numerical approach involves the development of a specialized grid generator (named HYGRID), an algebraic solution-adaptive grid scheme, and a modified flow solving method. A comparison of the results obtained for several waverider geometries with exact solutions, other numerical solutions, and experimental results demonstrated the ability of the new procedure to produce stagnation-free Euler solutions about sharp-edged configurations and to describe the physics of the flow in these regions. I.S.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 292)

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01

AERONAUTICS (GENERAL)

A93-30768
DRY-ICE BLASTING
Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 3 March 1993 p. 7-9.
Copyright

Dry-ice blasting technology that uses carbon dioxide pellets as a blasting medium is discussed. It is noted that the use of CO2 for cleaning and stripping operations may provide significant environmental, safety, and productivity improvements over grit blasting, plastic-media blasting, and chemical-solvent cleaning.
O.G.

A93-30769
COATING REMOVAL WITH HIGH-PRESSURE WATER JETS
Aerospace Engineering (ISSN 0736-2536) vol. 13, no. 3 March 1993 p. 19-23.
Copyright

Water-jet coating removal systems based on laser-drilled orifices mounted in a stripping nozzle is capable of providing precise water-jet directional and rotational control. A typical 0.014-inch-diameter water jet uses water at the rate of 1 gal/min, requires 50 hp at 50,000 psi, and projects an energy flux on the surface of about 260,000 hp/sq in. The water-jet parameters can be adjusted to affect only the coating leaving the base material unaffected. It is concluded that these systems provide benefits over conventional coating removal system which include complete, precise coating removal at high removal rates and without part damage; high productivity; flexible or dedicated manufacturing cell design; and elimination of environmental problems. O.G.

A93-30933*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
HIGH-ALTITUDE BALLOON-LAUNCHED AIRCRAFT - A PILOTED SIMULATION STUDY
JAMES E. MURRAY, TIMOTHY R. MOES, and KEN NORLIN (NASA, Flight Research Center, Edwards, CA) Feb. 1993 17 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1019) Copyright

A real-time piloted simulation at the NASA Dryden Flight Research Facility was used to study the feasibility of launching a research aircraft from a high-altitude balloon. In the study, the simulated aircraft was launched in a nosedown attitude at zero airspeed from 110,000 ft. After launch, the pilot flew the aircraft through a near-maximum-lift pullout and then through a zoom climb to a trimmed, l-g flight condition at the test altitude. The study included parametric variations to measure the effects of launch altitude, gross weight, Mach number limit, and parachute size on the test altitude attained. The aerodynamic model of the simulated aircraft was based on flight test results, low Reynolds number windtunnel tests, and computational models; the model included significant Mach number and Reynolds number effects at high altitude. A small parachute was included in the simulation to limit Mach number during the pullout to avoid adverse transonic effects and their resultant energy losses. A small rocket motor was included in the simulation and was investigated for boosting the aircraft to a higher test altitude. In the study, a test altitude of approximately 95,000 ft was attained without rocket boost, and a test altitude in excess of 100,000 ft was attained using small rocket boost.
Author

A93-30961#
COST EFFECTIVE ENGINE DESIGN FOR COMMERCIAL AIRCRAFT
ROBERT E. MATSON (USAir, Inc., Pittsburgh, PA) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1059) Copyright

Reliability and maintainability are key issues in the design process in order to build a cost effective engine. A lot of verbal tribute is paid to these important issues by the design community. Yet what does the average designer truly know about the environment which will utilize his or her product. The commercial airline industry is a tough and often unforgiving environment for turbofan engines. This paper will briefly explain the inner workings of the airline environment and the impact of reliability and maintainability on that particular environment. The paper will conclude by discussing several important guidelines such as access issues, borescope provisions, and field experience. These guidelines will enhance the designer's ability to ensure that a cost effective engine destined for airline operations is designed from the beginning.
Author

A93-30962#
THE ROLE OF PAINT SYSTEMS IN AIRCRAFT MAINTAINABILITY
GREGORY A. GARDNER (McDonnell Douglas Corp., Saint Louis, MO) and L. K. BAUMGARDNER (Bridge Associates, Frankfurt am Main, Germany) Feb. 1993 6 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1060) Copyright

Aircraft paint systems are extremely longlived and effective. This robust design means that, when they must be removed, these systems present significant difficulties to the maintenance centers facing the task. A summary of the paint-stripping processes available to aircraft overhaul centers shows that relatively cost effective processes can be selected, but that even the best present problems. The conclusion is that the real hope for alleviating this problem involves a redesign of the paint systems to make them more maintainable, not the development of better stripping processes for existing coatings.
Author

A93-31019#
THE CUSTOMER INFLUENCE IN 777 DESIGN
R. G. SCHAAD and J. M. HOPPER (Boeing Commercial Airplane Group, Seattle, WA) Feb. 1993 9 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1139) Copyright

The Boeing plan for the 777 airplane is to actively seek inputs from the airline customers and the internal design process customers in order to produce the airplane that is preferred. This

paper discusses the business processes and culture changes that were introduced to execute this plan and provides specific examples of changes in the configuration of the airplane and particular design details or features as a result of having this early coordination and input from these customers. Author

A93-31770
LONGITUDINAL STABILITY ANALYSIS OF AERIAL-TOWED SYSTEMS
NORIAKI NAKAGAWA and AKIRA OBATA (Japan Aircraft Manufacturing Co., Ltd., Yokohama) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 978-985. refs
Copyright

This paper presents an investigation into the longitudinal stability of aerial-towed systems consisting of a flexible, inextensible cable having a circular cross section and a symmetric rigid towed body. Coupled small motions of the towed system about steady-state conditions are studied. Equations governing the towed system are derived by the application of Lagrange's equations under an approximation in which the cable motion is expressed by finite degrees of freedom. Various modes and their stability are obtained by solving the eigenvalue problem of the linearized equations of motion. Three typical unstable motions are introduced by parametric studies of three types of towed systems and their stability conditions are examined. Author

A93-31938* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OVERVIEW OF NASA RESEARCH RELATED TO THE AGING COMMERCIAL TRANSPORT FLEET
CHARLES E. HARRIS and JOSEPH S. HEYMAN (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 64-68. AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, 32nd, Baltimore, MD, Apr. 8-10, 1991, Technical Papers. Pt. 2, p. 1661-1666. Previously cited in issue 12, p. 1900, Accession no. A91-32001 refs
Copyright

A93-32392
INTERNATIONAL HELICOPTER FORUM, 18TH, BUECKEBURG, GERMANY, MAY 16, 17, 1990, REPORTS [INTERNATIONALES HUBSCHRAUBER FORUM, 18TH, BUECKEBURG, GERMANY, MAY 16, 17, 1990, VORTRAEGE]
Bueckeburg, Germany International Helicopter Center 1990 337 p. In German and English. For individual items see A93-32393 to A93-32397
Copyright

Various papers on helicopter technology are presented. Individual topics addressed include: physical-technical limits of rotor systems, system for torque compensation in the helicopter main axis, helicopter evolution in the USSR, avionics systems for future helicopters, projection-screen oriented cockpit with night flight capability exemplified by the PAH-2 with digital display of navigation and tactics. AIAA

A93-32395
DEVELOPMENT OF HELICOPTERS IN THE USSR - GENERAL ASPECTS OF A SHIP-BASED HELICOPTER DEVELOPMENT
SERGEI V. MIKHEEV and V. G. KRYGIN (Kamov Design Bureau, Russia) *In* International Helicopter Forum, 18th, Bueckeburg, Germany, May 16, 17, 1990, Reports Bueckeburg, Germany International Helicopter Center 1990 p. 187-198.
Copyright

The development and characteristics of the Ka series of ship-based helicopters are briefly addressed. The main purposes of the helicopter, the kind of weapons it carries, and its overall dimensions are summarized and the helicopter airframe is described. The various operating conditions and their influence on the helicopter development are listed. AIAA

N93-22392# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Unternehmensbereich Flugzeuge.
AN EXPERT SYSTEM FOR THE DIAGNOSTIC AND MAINTENANCE OF VARIOUS AIRCRAFT COMPONENTS [EXPERTENSYSTEM FUER DIE DIAGNOSE UND WARTUNG UNTERSCHIEDLICHER KOMPONENTEN DES FLUGZEUGES]
JUERGEN FEY Sep. 1989 13 p In GERMAN Presented at DGLR e.V. Forschungsintitut fuer Anthropotechnik der FGAN e.V. 32nd Fachausschusssitzung, Ottobrunn, Germany, 19-20 Sep. 1989 Submitted for publication
(MBB-FE-363-S-PUB-0499; ETN-93-93438) Avail: CASI HC A03/MF A01

Maintenance costs are increasing in relation with the increasing complexity of avionic systems. The use of knowledge based systems is considered for airborne and ground based test techniques, in order to meet with the resulting requirements. A ground based diagnostic system is developed, which can give guidance to the maintenance engineer at debriefing, on a necessary checkout of avionic components on special testing bench. It can avoid suppposedly defective modules being unnecessarily replaced and expensive test procedures being undertaken. ESA

N93-22397# General Accounting Office, Washington, DC. National Security and International Affairs Div.
REPORT TO THE CHAIRMAN, SUBCOMMITTEE ON DEFENSE, COMMITTEE ON APPROPRIATIONS, HOUSE OF REPRESENTATIVES. INTELLIGENCE PROGRAMS: NEW RC-135 AIRCRAFT ENGINES CAN REDUCE COST AND IMPROVE PERFORMANCE
Aug. 1992 8 p
(AD-A259283; GAO/NSIAD-92-305) Avail: CASI HC A02/MF A01

In response to a request, information on the replacement of engines for the Department of Defense's fleet of 21 RC-135 aircraft are provided to the Subcommittee on Defense. This report addresses: (1) the estimated cost to replace the RC-135 aircraft's TF-33 engines; (2) the projected savings in future opearation and maintenance costs by replacing the engines; and (3) the operational benefits resulting from engine replacement. CASI

N93-22561*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
JOINT UNIVERSITY PROGRAM FOR AIR TRANSPORTATION RESEARCH, 1991-1992
FREDERICK R. MORRELL, comp. Washington Feb. 1993 169 p Conference held in Athens, OH, 18-19 Jun. 1992; sponsored by NASA, Washington and FAA
(Contract NGL-22-009-640; NGL-31-001-252; NGR-36-009-017; RTOP 505-64-52-01)
(NASA-CP-3193; L-17195; NAS 1.55:3193) Avail: CASI HC A08/MF A02

This report summarizes the research conducted during the academic year 1991-1992 under the FAA/NASA sponsored Joint University Program for Air Transportation Research. The year end review was held at Ohio University, Athens, Ohio, June 18-19, 1992. The Joint University Program is a coordinated set of three grants sponsored by the Federal Aviation Administration and NASA Langley Research Center, one each with the Massachusetts Institute of Technology (NGL-22-009-640), Ohio University (NGR-36-009-017), and Princeton University (NGL-31-001-252). Completed works, status reports, and annotated bibliographies are presented for research topics, which include navigation, guidance and control theory and practice, intelligent flight control, flight dynamics, human factors, and air traffic control processes. An overview of the year's activities for each university is also presented.

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A93-29927
NUMERICAL SIMULATION OF INTERACTION BETWEEN SUPERSONIC MAIN STREAM AND TRANSVERSE JET
WEIJIANG ZHOU, HANDONG MA, and FENG LI (Beijing Inst. of Aerodynamics, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 6-10. In Chinese. refs

The laminar N-S equations have been solved for a supersonic flow with a transverse sonic jet. The numerical algorithm used here is a second-order windward TVD scheme. The grid nodes are 121 x 95, compressed in both a transverse direction near the wall and a streamwise direction near the injector. The details of waves and vortex structures are obtained, and the flow field pictures and pressure distribution along plate are compared with experiments with good agreement. The calculation also demonstrates that the TVD scheme not only has high capability of shock capturing, but also can be applied to efficient simulation of the complex vortex structure. Author

A93-29928
COMPUTATION OF FLEXIBLE-WALL AIRFOIL FLOW USING N-S EQUATIONS
XIA MA, LINKUI XIAO, JINGGUI JIANG, and MIANCHUN CHANG (Chinese Academy of Sciences, Inst. of Mechanics, Beijing, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 11-14. In Chinese. refs

The 2D Reynolds-averaged compressible unsteady full Navier-Stokes equations are solved by using the Beam-Warming scheme with Baldwin-Lomax turbulent model about the flexible-wall airfoil. A method is proposed which can treat the locally changing surface of airfoils. The adaptive surface in the shock region can influence the shock/boundary layer interaction. Comparison has been made between the flow fields over NACA0021 airfoil with and without the flexible-wall. Since we use the time marching method to get steady results, the main difficulty in the present case is the treatment of the flexible wall boundary which changes its shape as the solution proceeds. The deflections of the flexible wall as function of the pressure over it can be found by the mechanics of the material. We propose a method of locally changing grids to avoid the global interpolation. Author

A93-29930
EXPERIMENTAL STUDY ON TURBULENT JET IN A CONFINED CROSSFLOW
MINGHOU XU, CAIYUAN HAN, and PINGFAN HU (Huazhong Univ. of Science and Technology, Wuhan, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 19, 20. In Chinese. refs

A turbulent triangular jet issuing perpendicularly into a confined gas-particle two-phase flow was investigated experimentally. When jet-to-crossflow velocity ratio R equaled to 2.5, mean and fluctuating velocity components were measured by the three-dimensional particle dynamics anemometry (3D PDA). The PDA signals were evaluated to yield the turbulent intensity and the particle concentration. The measurement results show that the turbulent intensity in the wake of the crossflow is enhanced, particularly on the edge of the recirculation zone. There are two particle concentration peaks, one of them is in the recirculation zone, and the other is on the edge of the zone. Author

A93-29931
INVESTIGATION OF STATIC PRESSURE FIELD IN AN S-SHAPED AIR INTAKE
PEIFEN WENG and RONGWEI GUO (Nanjing Aeronautical Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 21-23. In Chinese. refs

The static pressure fields in an s-shaped diffuser with rectangular cross section have been measured at different incidences. The results show that the static pressure field at the duct exit is nonuniform. The higher the angle of attack, the larger the distortion of the static pressure field. The pressure near the boundaries of the model is higher than that near the core, which is mainly caused by both the distorted total pressure field and the distorted flow velocity field. Further investigation on whirling flow field demonstrates that it is necessary to take into consideration the deviation between the experimental measurements and the weighted averages, by the use of the wall static pressures of the model at high incidence. Author

A93-29932
RESEARCH OF ONSET OF ROTATING STALL FOR MULTIPLE BLADE ROWS
JIUNQIANG ZHU and ZHIWEI LIU (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 24-28. In Chinese. refs

An inception criterion of rotating stall in multistage axial flow compressors is derived for an unsteady two-dimensional incompressible flow model, according to the small disturbance stability theory. By means of a three-vector equation system, the correlative equations of the undetermined parameters are deduced when the small disturbance theory is applied to multiple blade rows. The prediction of the rotating stall onset boundary in the multistage axial flow compressors has been accomplished with the computer program designed by the authors. A theoretical prediction approach is proposed with the aid of the prediction method of stable cascade characteristics. A good agreement was found between the analytical and experimental results. Author

A93-29933
ESTIMATION OF FLOW LOSS AT DESIGN POINT IN AN AXIAL-FLOW COMPRESSOR
CHANGSHENG ZHANG and XIAOLI WANG (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 29-33. In Chinese. refs

On the basis of statistical data and analysis of axial-flow compressors, the ratio of trailing-edge momentum thickness to chord length theta/c and trailing-edge form factor H are determined by the use of equivalent diffusion factor D(eq), and then the profile loss of the blade is obtained after appropriate corrections. Finally, the total loss distribution along the blade span of the axial-flow compressor is estimated according to an improved end-wall loss model and a shock loss model. An extensive comparison of the estimated loss data with the original design and test data shows that the loss model presented here is feasible for normal blade profile, double-circular-arc blade profile, and multi-circular-arc blade profile of axial-flow compressor, and the accuracy of the estimation is improved greatly. Author

A93-29934
EXPERIMENTAL STUDY ON UNSTABLE BEHAVIOR OF AXIAL COMPRESSION SYSTEM
JUN LI (Air Force Engineering College, Xian, China) and ZHIWEI LIU (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 34-36. In Chinese. refs

Unstable behavior of an axial-flow single-stage compressor has been researched successfully by use of a simple dynamic measuring system. The character and the influence factors of the unstable behavior have been analyzed from systematic view. The experimental results demonstrate that the unstable types of the compressor could convert each other at certain conditions. The compressor rotor speed, the construction, and the size of the exhaust parts are the main factors influencing the conversion. The surge occurs in the compressor in condition of high rotor

speed or large exhaust volume, otherwise the rotating stall appears. At high rotor speed, a stall phenomena of nonrecoverable stall appears. Its character is also considered. Author

A93-29936
STUDY OF A SUBSONIC COMBINED-LEANING TURBINE GUIDE VANE WITH TIP ENDWALL CONTOURING
HONGDE JIANG (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China), YONGLIANG LU, FANZHEN ZHOU, and SONGJUN WANG (Harbin Steam Turbine Work, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 41-44. In Chinese. refs

A three-dimensional, multigrid potentional flow computation method is developed to analyze subsonic flow in a steam turbine nozzle guide vane. In order to reduce the large secondary losses in the first annular nozzle guide vane with very small aspect ratio of 0.26 in a 300 MW steam turbine, both the tip endwall contouring and combined-lean blades are used in the new design. Experimental investigation shows that the mass-weighted loss coefficient of the new nozzle guide vane is 42 percent less than the traditional radial one. The agreement between the measured and calculated results of the pressure distribution on the blade surface in the annular nozzle guide vane is very good. Author

A93-29939
NUMERICAL STUDY ON BLADE-TO-BLADE PASSAGE FLOW FIELD IN A CENTRIFUGAL CASCADE
XIAOSONG WU and GUOCHUAN WU (Nanjing Aeronautical Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 53-55. In Chinese. refs

Numerical simulations of the blade-to-blade flow field in a centrifugal impeller have been carried on by using 2D mean steady incompressible Navier-Stokes equations and k-epsilon turbulent model in arbitrary boundary-fitted coordinate system. It is shown that the underrelaxation factors of line-by-line iteration are lower than those in nonrotational flow calculations and a more reasonable initial flow field is required due to the larger ratio of centrifugal forces in the source terms of momentum equations. The calculation results of the flow fields are in a good agreement with the LDA data with the exception of the near-wall region of the blade surfaces. Author

A93-30023
EFFECT OF STALL PHENOMENA ON VIBRATION PHENOMENA ENCOUNTERED IN WIND TUNNELS [INFLUENCE DES DECROCHAGES LOCAUX SUR LES PHENOMENES DE VIBRATIONS RENCONTRES EN SOUFFLERIE]
PHILIPPE DESTUYNDER and MARIE-THERESE RIBEREAU (Conservatoire National des Arts et Metiers, Saint-Cyr-l'Ecole, France) Academie des Sciences (Paris), Comptes Rendus, Serie II - Mecanique, Physique, Chimie, Sciences de la Terre et de l'Univers (ISSN 0764-4450) vol. 315, no. 13 Dec. 17, 1992 p. 1605-1610. In French. refs
Copyright

Based on wind-tunnel test data, a dynamic model is proposed which simulates the observed instabilities. Limit vibration cycles are obtained from a theoretical analysis of experimental data for a delta wing model with a canard. It is noted that, by understanding the nonlinear vibrations occurring in the unstable region, one can derive a mathematical model which can be employed to define the control loop of the model using the aerodynamic forces acting on it and measured for different positions of the moving parts of the aircraft. L.M.

A93-30095
EXPERIMENTAL INVESTIGATION OF COMPRESSOR CASCADE WITH CIRCUMFERENTIAL LEANED BLADE
ERBING SHANG, JIEXIAN SU, ZHONGQI WANG, WENYUAN XU, HONG SHI, and WENCAI LU (Harbin Inst. of Technology, China) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 13, no. 4 Nov. 1992 p. 363-368. In Chinese. refs

This paper investigates a rectilinear compressor cascade with an ordinary straight blade and a 25 deg tilted blade. The ink trace method is used for flow visualization. From five-hole probe measurements at the exit planes of cascades and flow visualizations, it can be concluded that positive tilting can eliminate the corner stall, while negative tilting increases the corner stall. Based on vortex dynamics, an attempt is being made to explain the mechanism of loss reduction. Author

A93-30096
ON TWO LAYERS OF CROSS VELOCITY MODEL AND ITS APPLICATION TO END WALL BOUNDARY LAYERS INSIDE AXIAL COMPRESSOR CASCADES
HU WU, FUQUN CHEN, and SONGLING LIU (Northwestern Polytechnical Univ., Xian, China) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 13, no. 4 Nov. 1992 p. 369-374. In Chinese. refs

Two layers of a cross velocity model are established for predicting end wall boundary layers inside axial compressor cascades based on the secondary flow theory, and the finite difference method is used to predict outer layer cross flow profile in the end wall boundary layer. A new method for predicting the blade force defect is proposed. Compared with the experimental results from two heavily loaded cascades, the predictions by this model show that the S-type cross flow profiles produced by high blade force defects can be computed automatically and accurately. Author

A93-30097
DESIGN AND TESTING OF SHOCK-FREE SUPERCRITICAL CASCADE
ZHENGMING WANG (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China), YONGXING CHUNG, GUOFAN WU (Ministry of Aeronautics and Astronautics, 624th Research Inst., China), and WU ZHANG (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 13, no. 4 Nov. 1992 p. 375-378. In Chinese. refs

Based on an algorithm for solving the inverse problem of transonic cascades in which the pressure distribution on blade surfaces is directly taken as a given condition, a numerical procedure has been developed for the design of shock-free supercritical compressor cascades. Some numerical methods of considering viscous influence are discussed. A shock-free supercritical cascade is tested. It is found that the experimental data are in good agreement with the predicted results. Author

A93-30098
AN EXPERIMENTAL STUDY OF ROTOR-STATOR UNSTEADY AERODYNAMIC INTERACTION IN A LOW-SPEED AXIAL FAN
LIXIN SHI, HONGDE JIANG, XIZHI LIANG, RUIXIAN CAI, GUIFEN DING, and HAI WU (Chinese Academy of Sciences, Inst. of Engineeering Thermophysics, Beijing, China) Journal of Engineering Thermophysics (ISSN 0253-231X) vol. 13, no. 4 Nov. 1992 p. 379-383. In Chinese. refs

A slant hot-wire sensor and the phase-locked technology are used to measure the moving wake of the rotor of a low-speed axial fan. KULITE transducers are mounted on the stator blade surface to measure the fluctuating pressure. The experimental results show that the rotor wakes decay on a power-law basis along the axial direction. In the leading edge area of stator blade the fluctuating pressure is strong and decays along the blade surface. The fluctuating character is determined by the distance between the rotor and the stator and the flow on the surface of the stator blade. Author

A93-30289* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
WALL PRESSURE FLUCTUATIONS IN THE REATTACHMENT REGION OF A SUPERSONIC FREE SHEAR LAYER
Z.-H. SHEN, D. R. SMITH, and A. J. SMITS (Princeton Univ., NJ) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 1-2 1993 p. 10-16. refs

(Contract NAG1-01072)
Copyright

A study was made of the wall pressure fluctuations in the reattachment region of a supersonic free shear layer. The free shear layer was formed by the separation of a Mach 2.9 turbulent boundary layer from a backward facing step. Reattachment occurred on a 20-deg ramp. By adjusting the position of the ramp, the base pressure at the step was set equal to the freestream pressure, and the free shear layer formed in the absence of any turning. An array of flush-mounted, miniature, high-frequency pressure transducers was used in the vicinity of the reattachment region to make multichannel measurements of the fluctuating wall pressure. Contrary to previous observations of this flow, the reattachment region was found to be highly unsteady, and the pressure fluctuations were found to be large. The overall behavior of the wall pressure loading is similar in scale and magnitude to the unsteadiness of the wall pressure field in compression ramp flows at the same Mach number. Author

A93-30293
RELIABILITY OF BI-ORTHOGONAL DECOMPOSITION APPLIED TO A ROTATING DISK BOUNDARY LAYER

S. CARRION (Aix-Marseille II, Univ., Marseille, France) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 1-2 1993 p. 59-64. refs
Copyright

An application of biorthogonal decomposition to an experiment on the transition of the boundary layer over a rotating disk is performed and compared with linear, wavelet, and Fourier analyses. We show how this biorthogonal decomposition can detect the results of these three methods, the critical Reynolds number 268) and the first transition Reynolds number (445), and a new Reynolds number (365) where the entropy fluctuates significantly, before nonlinear effects appear. Author

A93-30394
A NEW OPTICAL STUDY OF SUPERSONIC FLOW PAST WEDGE PROFILES BY HYDRAULIC ANALOGY

A. K. PAL and B. BOSE (Jadavpur Univ., Calcutta, India) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 3 1993 p. 210-213. refs
Copyright

A new optical method using hydraulic analogy has been developed for flow field visualization of transonic and supersonic flows. The flow field and oblique shock waves for flow past a slender wedge were investigated. Detailed experiments with alternating light and dark bands and optical prisms of different apex angles were performed. The orientation of the prisms and the angle of oblique shock waves observed were used for geometric determination of the depth of flow. A series of calibration experiments with optical prisms of different heights were conducted to determine the water depth of the flow field. This method may be useful for estimating quantitative parameters of high speed flow and may be used in conjunction with conventional high speed experiments and computational solution methods. A.O.

A93-30396
A LINEARIZED RIEMANN SOLVER FOR THE STEADY SUPERSONIC EULER EQUATIONS

ELEUTERIO F. TORO and CHENG-CHIANG CHOU (Cranfield Inst. of Technology, United Kingdom) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 16, no. 3 Feb. 15, 1993 p. 173-186. refs
Copyright

A very simple linearization of the solution to the Riemann problem for the steady supersonic Euler equation is presented. When used locally in conjunction with the Godunov method, computing savings by a factor of about four relative to the use of the exact Riemann solvers can be achieved. For severe flow regimes, however, the linearization loses accuracy and robustness. We then propose the use of a Riemann solver adaptation procedure. This retains the accuracy and robustness of the exact Riemann solver and the computational efficiency of the cheap linearized Riemann solver. Numerical results for two- and three-dimensional test problems are presented. Author

A93-30399
COMPUTATION OF TURBULENT ASYMMETRIC WAKE

E. G. TULAPURKARA, S. VENGADESAN, and J. LAKSHMINARASIMHAN (Indian Inst. of Technology, Madras, India) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 16, no. 3 Feb. 15, 1993 p. 239-248. Research supported by Centre for Development of Advanced Computing refs
Copyright

The development of asymmetric wake behind an aerofoil in turbulent incompressible flow has been computed using finite volume scheme for solving two-dimensional Navier-Stokes equations along with the k-epsilon model of turbulence. The results are compared with available experimental data. It is observed that the computed shift of the point of minimum velocity with distance is sensitive to the prescribed value of the normal component of velocity at the trailing edge of the aerofoil. Making the model constant C(mu) as a function of streamline curvature and changing the production term in the equation for epsilon, has only marginal influence on the results. Author

A93-30409
A WELL-POSED INVERSE DESIGN METHOD FOR TRANSONIC AIRFOIL

ZHIXUN XIA (National Univ. of Defence Technology, Changsha, China) and ZIQIANG ZHU (Beijing Univ. of Aeronautics and Astronautics, China) National University of Defense Technology, Journal (ISSN 1001-2486) vol. 14, no. 4 1992 p. 1-6. In Chinese. refs

From the Lighthill's exact solution for the incompressible inverse problem it is known that in the inverse design problem, the surface pressure distribution and the free stream speed cannot be both prescribed independently. This suggests the existence of a constraint (regularity condition) on the pressure distribution. The same constraint exists at compressible speeds. In this paper, a well-posed inverse design method for transonic airfoils is presented. In the method, the target pressure distribution contains a free parameter that can be adjusted during the computation to satisfy the regularity condition derived in this paper. Author

A93-30413
ANALYSES OF GLIDE AND STABILITY PERFORMANCE OF CONTROLLABLE PARAFOIL SYSTEMS

YUJUN GE and ZIZENG QIN (National Univ. of Defence Technology, Changsha, China) National University of Defense Technology, Journal (ISSN 1001-2486) vol. 14, no. 4 1992 p. 34-39. In Chinese. refs

The development of a controllable parafoil system provides the prospects for precise, undamaged recovery of large delicate payloads and recovery return systems intended for reuse. In this paper a six-degree-of-freedom flight dynamics model for such a system is presented and the simulation program is developed to aid the study of system performance such as glide and dynamic stability, etc. As an example, the glide and dynamic stability performance of 40 (sqm) area parafoil system has been discussed and some satisfactory results were obtained. Author

A93-30560
EXPERIMENTAL INVESTIGATION OF 2-D INLET MODEL IN NON-UNIFORM SUPERSONIC FLOW

KUNYUAN ZHANG and G. E. A. MEIER (Nanjing Aeronautical Inst., China) Journal of Propulsion Technology (ISSN 1001-4055) no. 1 Feb. 1993 p. 9-15. In Chinese. refs

The present experimental study of a 2D inlet in nonuniform supersonic flow was conducted at nominal Mach numbers of 2.25 and 2.5, with a configuration in which the inlet model fully or partly ingested the boundary layer of the upper wall surface. The results thus obtained show that the ramp shock/boundary layer interaction was significantly affected by the behavior of the

boundary layer bleed gap and the flow nonuniformity at the inlet model entrance. The length of this interaction first increased, and then was rapidly reduced, when the boundary layer height exceeded that of the bleed gap. O.C.

A93-30562
SIMULATION OF FLOW FIELD WITH A LARGE DISTORTION VALUE AT OUTLET OF INLET
DEWANG LIANG and SHIYING ZHANG (Nanjing Aeronautical Inst., China) Journal of Propulsion Technology (ISSN 1001-4055) no. 1 Feb. 1993 p. 22-27. In Chinese.

A flow field with a large distortion value at an inlet's outlet is presently treated via plate simulation for four different, large distortion values. The distortion contour mapping of the steady-state total pressures is shown to be accurate, and the distortion value of the flow field simulated can be greatly enhanced through the addition of a small radial plate on the plate simulator. Total pressure recovery, turbulence level, and distortion contour maps are obtained. O.C.

A93-30835 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NEW APPROACH FOR THE CALCULATION OF TRANSITIONAL FLOWS
T. W. YOUNG, ERIC S. WARREN (North Carolina State Univ., Raleigh), JULIUS E. HARRIS (NASA, Langley Research Center, Hampton, VA), and H. A. HASSAN (North Carolina State Univ., Raleigh) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 629-636. Previously cited in issue 19, p. 3249, Accession no. A92-45524 Research supported by USAF and U.S. Navy refs
(Contract NCC1-22; NAGW-1022; NAGW-1331)
Copyright

A93-30837* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GRID-INDEPENDENT UPWIND SCHEME FOR MULTIDIMENSIONAL FLOW
IJAZ H. PARPIA and DONNA J. MICHALEK (Texas Univ., Arlington) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 646-651. refs
(Contract NAG1-1207)
Copyright

Recent advances in the development of a grid-independent finite volume scheme for the Euler equations of gas dynamics are described. In the proposed method, flowfield gradient data are reconstructed locally (on a triangle) using five elementary planar waves, and an upwind numerical flux function for grid-oblique waves is developed to model the effect of the passage of these waves on the data in a cell. Numerical examples for several two-dimensional test problems are included. These results show high wave resolution and nearly monotone strong-wave transitions. Author

A93-30838
EXPERIMENTAL INVESTIGATION OF HYPERSONIC THREE-DIMENSIONAL CORNER FLOW
HAKAN PAPUCCUOGLU (Istanbul Technical Univ., Turkey) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 652-656. Research supported by von Karman Inst. for Fluid Dynamics refs
Copyright

The high heat transfer rates and flow pattern were investigated in the vicinity of a 90-deg axial corner at a Mach number of 6 and over a Reynolds number range from 7 to 22.5 x 10 exp 6. The investigation was carried out for two different corner configurations, one that involves two 9-deg half-angle unswept intersecting wedges and the other one that consists of a 9-deg half-angle unswept wedge and a flat plate aligned with the freestream. In this study it was observed that, in some cases, there are three and even four peaks of aerodynamic heating in the corner region. To give a reasonable physical explanation for the results of the experiments, two different vortex systems have been developed qualitatively in the boundary layer. A sharp decrease of heating detected in the region very near the corner centerline is attributed to the mutual interaction of the surface boundary layers, as also indicated in the literature, and a pair of small vortices causing the flow to lift off the surface. Author

A93-30839
BASE PRESSURE OF A SUDDEN EXPANSION FROM A CONICAL CONVERGING NOZZLE
CHI-BOK HWANG (Joint Chiefs of Staff, Seoul, Republic of Korea), WEN L. CHOW, and DAVOOD MOSLEMIAN (Florida Atlantic Univ., Boca Raton) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 657-662. refs
Copyright

This investigation concerns the determination of the back-pressure-independent base pressure related to the conical convergent nozzle flow with a sudden enlargement in cross-sectional area. It is recognized at the outset that the problem belongs to the category of strong interaction, where inviscid and viscous flows must be considered together before a solution can be established. The viscous flow analyses, based on the integral formulations, are guided more or less by the boundary-layer concept. The inviscid flowfield is established from the hodograph transformation and the method of characteristics. The point of reattachment behaves as a saddle point singularity for the system of equations describing the viscous flow recompression process. In conjunction with an overall momentum balance, the base pressure and the location within the wake region where recompression starts can be determined. Experimental studies of sudden expansion from conical converging nozzles with specific conical angles and area ratios are also conducted in the laboratory. The results obtained from the theoretical analysis agree fairly well with the experimental data. These results lead to the conclusion that the method developed in this investigation is effective in dealing with problems of this type. Author

A93-30843* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
QUASICONICAL FREE INTERACTION BETWEEN A SWEPT SHOCK AND A TURBULENT BOUNDARY LAYER
FRANK K. LU (Texas Univ., Arlington) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 686-692. refs
(Contract AF-AFOSR-86-0092; NCA2-1R589-502)
Copyright

Previous observations that fin-generated interactions are quasi-conical in nature were further confirmed by surface pressure measurements spanning Mach 2.5-3.5, which encompassed unseparated through strongly separated interactions. For strongly separated interactions in which the shock wave is bifurcated into a lambda-foot structure, the conical free interaction hypothesis was validated through an appropriate scaling of the far-field surface pressure distribution. The behavior of the lambda-foot structure, such as the decrease of the slope of the separation shock with interaction strength, was explained by invoking the conical free interaction hypothesis. Through the conical free interaction hypothesis, it was further shown that the triple-shock intersection behaves in a complicated manner with changes in interaction strength. Author

A93-30846* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COUPLING BETWEEN A SUPERSONIC BOUNDARY LAYER AND A FLEXIBLE SURFACE
ABDELKADER FRENDI (Analytical Services and Materials, Inc., Hampton, VA), LUCIO MAESTRELLO (NASA, Langley Research Center, Hampton, VA), and ALVIN BAYLISS (Northwestern Univ., Chicago, IL) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 708-713. Previously cited in issue 05, p. 712, Accession no. A93-19132 refs
(Contract NAS1-19317; NAS1-18107; NAS1-18605)
Copyright

A93-30857
COMPARATIVE NUMERICAL STUDY OF TWO TURBULENCE MODELS FOR AIRFOIL STATIC AND DYNAMIC STALL
DONALD P. RIZZETTA and MIGUEL R. VISBAL (USAF, Wright Lab., Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 784-786. Abridged. Previously cited in issue 23, p. 4057, Accession no. A92-55394 refs
Copyright

A93-30893#
DESIGN AND OPTIMIZATION METHOD FOR MULTI-ELEMENT AIRFOILS
MARK DRELA (MIT, Cambridge, MA) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Research supported by NSF refs
(AIAA PAPER 93-0969) Copyright

An interactive design and optimization framework for the development of multielement airfoils is presented. A zonal Euler/boundary-layer flow solver is used as the underlying analysis method. The full Newton solution method of the solver permits effectively 'free' calculation of flowfield sensitivities to airfoil element shape deformation modes and rigid-body element translation and rotation modes. The sensitivity of any aerodynamic quantity of interest to all the geometric parameters is thus obtained. Single-point and multi-point optimization and least-squares inverse techniques are constructed with the sensitivity information. The method's incorporation of many design variables into interactively-specified design and/or optimization problems makes it particularly effective in multielement airfoil development. Applications are presented for multipoint optimization of a novel two-element transonic cruise airfoil with a thickness constraint, and 2) C sub L(max) optimization of a four-element landing configuration airfoil. Author

A93-30894#
SUPERSONIC AXISYMMETRIC CONICAL FLOW CHARTS FOR DIFFERENT RATIOS OF SPECIFIC HEATS
BHAVESH B. PATEL, B. K. HODGE, and KEITH KOEING (Mississippi State Univ., Mississippi State) Feb. 1993 14 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-0970) Copyright

Charts for the axisymmetric supersonic flow of a calorically perfect gas over cones have been assembled for values of the ratio of specific heats from 1.000001 to 1.67, the limiting values, in increments of 0.1. The format for the charts follows quite closely that of the NACA TR-1135. The effects of the ratio of specific heats on conical supersonic flow features are examined and delineated. Author

A93-30895#
SUPERSONIC/HYPERSONIC FLIGHT VEHICLE FOREBODY WAVE DRAG DETERMINATION USING AN EULER-BASED CFD APPROACH
J. T. WHITE (Hughes Missile Systems Co., Pomona, CA) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-0971) Copyright

Presented herein is a practical method for accurately calculating flight vehicle forebody wave drag in the supersonic/hypersonic flight regime. Given the forebody moldline shape, the forebody fineness ratio, and the flight Mach number, the wave drag coefficient is computed via easy-to-use design curves. A wide variety of forebody moldline shapes is treated including tangent ogive, conical, L-D Haack (i.e., a Von-Karman ogive), L-V Haack, parabolic series, and power law (minimum drag) bodies. The foundation of the wave drag prediction methodology is Computational Fluid Dynamics (CFD). Specifically, the steady, compressible, inviscid flow about a family of forebody moldline shapes was parametrically calculated using an Euler-based CFD flow solver. The method presented here has been validated through comparison of thr predicted results with wind tunnel test-derived experimental wave drag coefficient data. The predicted/experimental agreement is exceptional for each validation case; with an average prediction error of less than 3 percent. Author

A93-30896#
INVERSE AIRFOIL DESIGN USING THE NAVIER-STOKES EQUATIONS
S. EYI and K. D. LEE (Illinois Univ., Urbana) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-0972) Copyright

The feasibility of the use of the Navier-Stokes equations in aerodynamic design is examined. The Navier-Stokes equations can include the rotational viscous physics at transonic speeds, and hence are expected to produce more reliable design. The target pressure is specified and a least-square optimization is used to minimize the pressure discrepancy between the target and designed airfoils. The sensitivity analysis which determines the response of the flow to a geometry perturbation is performed based on a finite difference evaluation. The performance of the design method is evaluated with various design practices. Author

A93-30930#
USING POP-UP VORTEX GENERATORS ON THE WING SURFACE TO GREATLY INCREASE THE LIFT AND STALL ANGLE OF ATTACK
DAVID MANOR, CRIN DIMA, PEDRO SCHOCH, and JAVIER POLO (Parks College, Cahokia, IL) Feb. 1993 7 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1016) Copyright

A series of vortex generators were applied to 15 percent thick aspect ratio 2 and 4 wing configurations. The vortex generators vary in shape, size and location to obtain optimum increase in lift and stall angle of attack. Preliminary studies done in the Parks College of St. Louis University wind tunnel indicates that the lift coefficient and the stall angle of attack may be doubled with the application of vortex generators. This paper identifies the optimum configuration(s) and in addition, the optimum configurations were tested in the Parks College of Saint Louis University water tunnel to correlate the added forces results to the flow field. Author

A93-30932# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
WIND TUNNEL MEASUREMENTS ON A FULL-SCALE F/A-18 WITH FOREBODY SLOT BLOWING OR FOREBODY STRAKES
WENDY R. LANSER (NASA, Ames Research Center, Moffett Field, CA) and DANIEL G. MURRI (NASA, Langley Research Center, Hampton, VA) Feb. 1993 13 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1018) Copyright

Results are presented of tests, conducted on a full-scale F/A-18 in the 120-Foot Wind Tunnel at NASA Ames Research Center, to measure the effectiveness of a 16-in.-long tangentially blown slot and of deployable strakes (measuring 4 ft in length) positioned on the aircraft's forebody. Fixed strakes with deflections of 30, 60, or 90 deg were tested to simulate the deployment of conformal actuated forebody strakes. It is shown that both the tangentially blown slot and the deployable strakes are effective in generating large yawing momemts at high angles of attack, without inducing significant coupling in the other axes. I.S.

A93-31102
ANALYSIS OF FLOW IN THE BLADE PASSAGES OF TURBINE NOZZLE RINGS THROUGH FLOW TRAVERSING INSIDE THE PASSAGE [OSOBENNOSTI ISSLEDOVANIIA TECHENII V MEZHLOPATOCHNYKH KANALAKH SOPLOVYKH APPARATOV TURBIN TRAVERSIROVANIEM POTOKA VNUTRI KANALA]
N. V. ESHCHENKO *In* Gas dynamics in jet-engine units and

components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 4-6. In Russian.
Copyright

To analyze flow inside the blade passage of a turbine nozzle ring, the total pressure over the height of a blade was measured at six points along the middle line of the blade passage by drilling six holes in the baffle plate. The measurements were carried out on a plane cascade bench equipped with a wind tunnel. By traversing the total and static pressure fields at the cascade exit, it is shown that the zone of secondary flows shifts toward the end wall with increasing distance from the trailing edges of the blades, becoming less pronounced due to flow equalization. V.L.

A93-31103
A SIMPLE ALGORITHM FOR SMOOTHING BLADE PROFILE OUTLINES [PROSTOI ALGORITM SGLAZHIVANIIA OBVODOV PROFILEI LOPATOK]
A. K. SITNIKOV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 7-9. In Russian.
Copyright

A sufficiently simple and compact algorithm is proposed for smoothing blade profile outlines within the specified smoothing limits. The algorithm is computationally efficient, does not require a large amount of ready-access memory, and can be used in a variety of problems involving the analysis and design of blade profiles and blade flow calculations. V.L.

A93-31104
CHARACTERISTICS OF BLADE PROFILING FOR A BIROTATORY TURBINE WITHOUT AND INTERMEDIATE NOZZLE RING [OSOBENNOSTI PROFILIROVANIIA LOPATOK BIROTATIVNOI TURBINY BEZ PROMEZHUTOCHNOGO SOPLOVOGO APPARATA]
S. L. MKHITARIAN and V. IU. GLEBOV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 10-15. In Russian. refs
Copyright

The operation of birotatory turbines is investigated analytically for different types of blade profiles. In particular, attention is given to the turbine of a two-shaft bypass engine with an afterburner with an inlet gas temperature of 2400 K. Results are presented for two types of blades corresponding to two different profiling laws. It is shown that the selection of the profiling law for the first-stage blades determines the operation characteristics of the second stage and its efficiency. V.L.

A93-31109
ANALYSIS OF FLOW STRUCTURE IN THE REGION OF INTERFERENCE BETWEEN TWO INTERSECTING PLANES [ANALIZ STRUKTURY POTOKA V OBLASTI INTERFERENTSII DVUKH PERESEKAIUSHCHIKHSIA PLOSKOSTEI]
V. I. TOLMACHEV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 31-35. In Russian. refs
Copyright

The paper is concerned with the structure of supersonic flow past an angle body formed by two intersecting wedges. A method for calculating such flows and a calculation example are presented. The method is based on relations for an oblique shock wave and analytical geometry. Calculations are carried out by decomposing the velocity vector into two (normal and tangential) components. V.L.

A93-31110
CALCULATION OF THE FLOW COEFFICIENT OF A PLANE SUPERSONIC AIR INTAKE USING A TWO-DIMENSIONAL PROGRAM WITH ALLOWANCE FOR THREE-DIMENSIONAL FLOW SPREADING AHEAD OF THE INTAKE [RASCHET KOEFFITSIENTA PLOSKOGO SVERKHZVUKOVOGO VOZDUKHOZABORNIKA PO DVUMERNOI PROGRAMME S UCHETOM PROSTRANSTVENNOGO RASTEKANIIA POTOKA PERED VKHODOM]
V. V. DUGANOV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 35-38. In Russian. refs
Copyright

A method is proposed for including the three-dimensional effect of flow spreading at the intake section of a plane air intake into a two-dimensional air intake flow calculation program. The intensity of the lateral flow rate due to spreading is calculated using Remeev's formulas. Flow losses due to spreading are added to flow losses determined in the two-dimensional calculations. Details of the two-step calculation procedure are summarized. V.L.

A93-31111
A MODEL OF SUPERSONIC GAS-DROPLET FLOWS WITH ALLOWANCE FOR INTERPHASE HEAT AND MASS TRANSFER [MODEL' SVERKHZVUKOVYKH GAZOKAPEL'NYKH TECHENII S UCHETOM MEZHFAZNOGO TEPLOMASSOOBMENA]
A. I. TURISHCHEV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 38-44. In Russian. refs
Copyright

The mixing and evaporation of sprayed TS-1 kerosene was investigated experimentally, and the results were used to test the validity of a mathematical model for various types of flow. The size and concentration of fuel droplets were measured by low-angle scattering and laser attenuation methods; the mean fuel droplet velocity was measured by the time-of-flight method. The theoretically and experimentally determined mean velocities and distributed densities of the droplets are found to be in qualitative and quantitative agreement. V.L.

A93-31114
APPROXIMATE CALCULATION OF THE PARAMETERS OF SUPERSONIC FLOW IN A DIVERGENT CHANNEL WITH STAGNATION IN THE PSEUDOSHOCK [PRIBLIZHENNYI RASCHET PARAMETROV SVERKHZVUKOVOGO POTOKA V RASSHIRIAIUSHCHEMSIA KANALE PRI TORMOZHENII V PSEVDOSKACHKE]
A. A. LIULIKOV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 56-63. In Russian. refs
Copyright

The characteristics of the pseudoshock in a divergent channel are examined with reference to results of recent experimental and theoretical studies. In some of these studies, certain characteristics of the pseudoshock in a straight channel are extended to the pseudoshock in a divergent channel. Here, the validity of this and other assumptions is examined on the basis of the available experimental data. V.L.

A93-31116
EFFECT OF SUPERSONIC COMPRESSIBILITY ON TURBULENT MIXING [O VLIIANII SVERKHZVUKOVOI SZHIMAEMOSTI NA TURBULENTNOE SMESHENIE]
V. A. PERMINOV and O. V. SPIRIDONOV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 68-77. In Russian. refs
Copyright

A modified version of the K-epsilon turbulence model proposed by Dash (1983) is presented and tested on submerged and coflowing supersonic jets. The calculations are carried out using a program for computing two-dimensional mixing layers in the

boundary layer approximation. The importance of including the effect of flow compressibility in calculating supersonic flows, including submerged and coflowing supersonic jets, is demonstrated. The improved accuracy of the model is illustrated by an example. V.L.

A93-31154
CALCULATION OF HEAT TRANSFER IN FRICTION IN LAVAL NOZZLES USING TRANSPORT EQUATIONS FOR TURBULENCE CHARACTERISTICS [RASCHET TEPLOOBMENA I TRENIIA V SOPLAKH LAVALIA S PRIMENENIEM TRANSPORTNYKH URAVNENII DLIA TURBULENTNYKH KHARAKTERISTIK]
G. P. KALMYKOV, A. V. DMITRENKO, and L. D. GUTKIN Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 14-19. In Russian. refs
Copyright

Results of calculations of the boundary layer in Laval nozzles based on an original turbulence model are reported. The relations obtained here are compared with experimental data for Laval nozzles and relations calculated from integral expressions. The results provide a way to quantitatively estimate the advantages of moment methods over the integral methods for calculating heat transfer and friction in nozzles. V.L.

A93-31158
NUMERICAL IMPLEMENTATION OF A TWO-DIMENSIONAL MODEL OF UNSTEADY FLOW IN A RADIAL-AXIAL BLADE MACHINE [CHISLENNAIA REALIZATSIIA DVUMERNOI MODELI NESTATSIONARNOGO TECHENIIA V RADIAL'NO-OSEVOI LOPATOCHNOI MASHINE]
A. V. AMBROZHEVICH Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 33-37. In Russian. refs
Copyright

A finite difference method is proposed for implementing a flow model in a radial-axial blade machine. The approach is based on splitting in terms of physical processes. A family of explicit multiple-step difference schemes is obtained. The schemes represent the effect of various factors, specified in the model by source-sink singularities, in the form of an efficient general-purpose homogeneous algorithm. V.L.

A93-31159
A METHOD OF PROFILING AND ANALYTICAL-EXPERIMENTAL STUDIES OF A SUPERSONIC THREE-DIMENSIONAL AIR INTAKE [METODIKA PROFILIROVANIIA I RASCHETNO-EKSPERIMENTAL'NYE ISSLEDOVANIIA SVERKHZVUKOVOGO PROSTRANSTVENNOGO VOZDUKHOZABORNIKA]
A. D. BOROVIKOV, V. V. DUGANOV, and N. N. ZAKHAROV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 37-40. In Russian. refs
Copyright

A method is presented for optimizing the flow path of a supersonic three-dimensional air intake up to the 'neck' section for maximum full pressure recovery coefficient in a system of shock waves. A model of a three-dimensional air intake for M 3 is developed. Results of an experimental study of flow past a model in the M range 2.5-4 are presented. The design calculations based on McCormack's three-dimensional finite difference scheme are found to be in satisfactory agreement with experimental data. V.L.

A93-31170
SELECTION OF THE EXIT SECTION GEOMETRY FOR COOLED TURBINE BLADE PROFILES [K VYBORU GEOMETRII VYKHODNOI CHASTI PROFILEI OKHLAZHDAEMYKH LOPATOK TURBINY]
B. I. MAMAEV and T. I. SHUVEROVA Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 76-79. In Russian. refs
Copyright

The effect of the thinning of the trailing edge of a blade on the gasdynamic characteristics of cascades and the back pressure during the drainage of the coolant from the blades is investigated experimentally. It is shown that the use of thinned blades, with the cooling air exiting onto a trough near the trailing edge, makes it possible to minimize energy losses and reduce the back pressure. Optimal edge thinning should allow a trough deflection of not more than 12-14 degrees, with the channel width between the profiles remaining approximately constant. V.L.

A93-31176
A STUDY OF WAVE LOSSES OF THRUST USING A DIFFERENTIAL APPARATUS [ISSLEDOVANIE VOLNOVYKH POTER' TIAGI NA DIFFERENTSIAL'NOI USTANOVKE]
V. V. SEMENOV and A. A. TALALAEV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 95-98. In Russian. refs
Copyright

A general approach to the design of the main components of a differential test apparatus is presented. A new type of a force transducer consisting of elastic elements with bonded strain gages is proposed which makes it possible to improve the accuracy of force measurements. Results of experimental studies of wave losses of thrust in supersonic nozzles with a textured surface are presented. V.L.

A93-31217
THE GLOBAL ITERATION METHOD FOR SOLVING THREE-DIMENSIONAL EQUATIONS OF A VISCOUS SHOCK LAYER [METOD GLOBAL'NYKH ITERATSII DLIA RESHENIIA TREKHMERNYKH URAVNENII VIAZKOGO UDARNOGO SLOIA]
A. I. BORODIN and S. V. PEIGIN (NII Prikladnoi Matematiki i Mekhaniki, Tomsk, Russia) Teplofizika Vysokikh Temperatur (ISSN 0040-3644) vol. 30, no. 6 Nov.-Dec. 1992 p. 1124-1129. In Russian. refs
Copyright

The paper deals with the hypersonic three-dimensional flow of a viscous homogeneous gas in a shock layer near blunt bodies. Three-dimensional equations of a viscous shock layer with an unknown shape of the shock wave are solved by using a modified version of the global iteration method. The organization of the computational process in each iteration is described, and methods of accelerating iteration convergence are discussed. It is shown that the use of global iterations in terms of the shock wave shape makes it possible to significantly expand the applicability region of the model of a hypersonic viscous shock layer to larger values of the marching coordinate. V.L.

A93-31492
THEORETICAL ANALYSIS OF RADIAL EQUILIBRIUM ON INLET AND OUTLET OF THE COMPRESSOR AXIAL STAGE ROTOR WITH THE LAW OF BLADES TWIST C SUB U R EXP -M AND WITH VARIABLE WORK ALONG THE WORKING BLADE LENGTH [ANALIZA TEORETYCZNA ROWNANIA ROWNOWAGI PROMIENIOWEJ PRZED I ZA WIRNIKIEM OSIOWEGO STOPNIA SPREZAJACEGO PROFILOWANEGO WEDLUG ZASADY C SUB U R -M = IDEM ZE ZMIENNA PRACA WZDLUZ WYSOKOSCI LOPATKI ROBOCZEJ]
STANISLAW ANTAS (WSK PZL, Zaklad Badawczo-Rozwojowy, Rzeszow, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669) no. 131 1992 p. 71-85. In Polish. refs

The new form of a solution for a radial equilibrium equation at variable work along the blade length is presented. A functional dependence of the explicit form, useful for engineering practice, is obtained. The analysis is performed on the basis of the assumed model of flow in an axial clearance between a rotor ring and a stator ring. At the final stage of the theoretical analysis, the particular form of a solution of equilibrium equation is obtained. Author

A93-31494* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SEMI-EMPIRICAL MODEL FOR PREDICTION OF UNSTEADY FORCES ON AN AIRFOIL WITH APPLICATION TO FLUTTER
A. J. MAHAJAN, K. R. V. KAZA (NASA, Lewis Research Center,

Cleveland, OH), and E. H. DOWELL (Duke Univ., Durham, NC) Journal of Fluids and Structures (ISSN 0889-9746) vol. 7, no. 1 Jan. 1993 p. 87-103. Previously announced in STAR as N92-18760 refs
(Contract NAG3-724)
Copyright

A semi-empirical model is described for predicting unsteady aerodynamic forces on arbitrary airfoils under mildly stalled and unstalled conditions. Aerodynamic forces are modeled using second order ordinary differential equations for lift and moment with airfoil motion as the input. This model is simultaneously integrated with structural dynamics equations to determine flutter characteristics for a two degrees-of-freedom system. Results for a number of cases are presented to demonstrate the suitability of this model to predict flutter. Comparison is made to the flutter characteristics determined by a Navier-Stokes solver and also the classical incompressible potential flow theory. Author

A93-31617
COMPUTATIONAL MODELLING OF SHOCK WAVE/BOUNDARY LAYER INTERACTION WITH A CELL-VERTEX SCHEME AND TRANSPORT MODELS OF TURBULENCE
M. A. LESCHZINER, K. P. DIMITRIADIS, and G. PAGE (Univ. of Manchester Inst. of Science and Technology, United Kingdom) Aeronautical Journal (ISSN 0001-9240) vol. 97, no. 962 Feb. 1993 p. 43-61. Research supported by Defence Research Agency and CEC refs
Copyright

The paper describes a procedure for computational modeling the interaction between shock waves and attached or separated turbulent boundary layers. The numerical framework, which combines cell-vertex storage, a Lax-Wendroff time-marching scheme, and multigrid convergence acceleration, is applicable to general curved grids. A comparison was made of the predictive performance of alternative transport models of turbulence, with particular attention given to the comparison between the variants of low Reynolds number k-epsilon models with an algebraic variant of a Reynolds-stress transport closure in strong interaction situations, including shock-induced separation. Results showed that most features of the attached flows investigated were relatively insensitive to the choice of turbulence models examined, with an exception of Chin's model, which had a tendency to return an erroneous representation of the semiviscous near-wall region. I.S.

A93-31771* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
UNSTEADY SIMULATION OF VISCOUS FLOWFIELD AROUND F-18 AIRCRAFT AT LARGE INCIDENCE
YEHIA M. RIZK (NASA, Ames Research Center, Moffett Field, CA) and KEN GEE (MCAT Inst., Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 986-992. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0020. Previously cited in issue 07, p. 968, Accession no. A91-21338 refs
Copyright

A93-31775
AERODYNAMIC DESIGN VIA OPTIMIZATION
K. D. LEE and S. EYI (Illinois Univ., Urbana) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1012-1019. AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2, p. 677-687. Previously cited in issue 23, p. 4003, Accession no. A91-53787 refs
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A93-31776
AERODYNAMIC SHAPE DESIGN AND OPTIMIZATION - STATUS AND TRENDS
GEORGE S. DULIKRAVICH (Pennsylvania State Univ., University Park) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1020-1026. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0476. Previously cited in issue 07, p. 973, Accession no. A91-21506 refs
Copyright

A93-31777
PHYSICAL MODELING OF GROUND EFFECTS ON VORTEX WAKES
H.-T. LIU, P. A. HWANG, and R. A. SRNSKY (QUEST Integrated, Inc., Kent, WA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1027-1034. Research supported by QUEST Integrated, Inc. refs
(Contract DTRS-57-87-C-0019)
Copyright

Towing-tank experiments were conducted to investigate ground effects on vortex wakes. Two methods were used to generate the vortex wakes: 1) a towed NACA 0012 wing and 2) a slotted-jet vortex generator. Trajectories derived from trailing vortex wakes, tagged with a fluorescent dye and released near the simulated ground surface, have confirmed the inadequacy of the two-dimensional inviscid solution. The generation of a relatively weak secondary vortex causes the primary vortex to rebound from the surface as a result of unsteady separation. There is no significant difference between the trajectories, whether the ground is simulated by a rigid surface or a free surface. The introduction of a rigid surface close to the exit of the slotted-jet vortex generator results in the formation of secondary vortices at the ground outboard of the primary vortices. The secondary vortices generated by the slotted-jet vortex pair are more coherent and persistent than those generated by the trailing vortex pair. A simple modification of the two-dimensional inviscid theory - namely, adding a secondary vortex to the system - recreates the rebound phenomenon, which agrees qualitatively with the trend seen in the experiments. Author

A93-31780
NUMERICAL SIMULATION OF RE-ENTRY FLOW AROUND THE SPACE SHUTTLE WITH FINITE-RATE CHEMISTRY
YASUHIRO WADA (National Aerospace Lab., Tokyo, Japan) and HIROTOSHI KUBOTA (Tokyo Univ., Japan) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1049-1056. refs
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Hypersonic flow around the Space Shuttle is computed for a series of re-entry flight conditions by incorporating a one-temperature model that takes into account 7-species finite-rate chemistry. An implicit higher-order upwind scheme based on a generalized Roe's approximate Riemann is used. The aerodynamic characteristics and heating rates are compared with the STS-2 flight data, and good agreement is obtained. These results quantitatively confirm the measured forward shift of the center of pressure and reduction of heating rates caused by real gas effects. Author

A93-31785
MULTIGRID EULER CALCULATIONS OVER COMPLETE AIRCRAFT
D. M. TIDD, D. J. STRASH (Analytical Methods, Inc., Redmond, WA), B. EPSTEIN, A. LUNTZ, A. NACHSHON, and T. RUBIN (Israel Aircraft Industries, Ltd., Tel Aviv) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1080-1085. AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1, p. 288-296. Previously cited in issue 23, p. 4000, Accession no. A91-53753 refs
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A93-31786
SOURCES OF HIGH ALPHA VORTEX ASYMMETRY AT ZERO SIDESLIP
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1086-1090. AIAA, Fluid Dynamics,

Plasma Dynamics and Lasers Conference, 22nd, Honolulu, HI, June 24-26, 1991, AIAA Paper 91-1810. Previously cited in issue 17, p. 2860, Accession no. A91-42604 Research supported by Lockheed Missiles and Space Co., Inc refs
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A93-31787
WIND-TUNNEL INVESTIGATION OF A FIGHTER MODEL AT HIGH ANGLES OF ATTACK
SHESHAGIRI K. HEBBAR and DAVID H. LEEDY (U.S. Naval Postgraduate School, Monterey, CA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1091-1097. AIAA Applied Aerodynamics Conference, 8th, Portland, OR, Aug. 20-22, 1990, Technical Papers. Pt. 1, p. 452-462. Previously cited in issue 21, p. 3287, Accession no. A90-45886 Research supported by U.S. Navy refs

A93-31788
PROPELLER SLIP-STREAM MODEL IN SUBSONIC LINEARIZED POTENTIAL FLOW
PER LOFSTEDT (Saab-Scania, AB, Linkoping, Sweden) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1098-1105. ICAS, Congress, 17th, Stockholm, Sweden, Sept. 9-14, 1990, Proceedings. Vol. 1, p. 733-744. Previously cited in issue 09, p. 1307, Accession no. A91-24383 refs
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A93-31789
TRANSONIC LOW-REYNOLDS NUMBER AIRFOILS
MARK DRELA (MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1106-1113. AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, AIAA Paper 91-3337. Previously cited in issue 23, p. 4009, Accession no. A91-53880 Research supported by MIT and NSF refs
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A93-31791
UNSTEADY WIND-TUNNEL INTERFERENCE IN AIRCRAFT DYNAMIC EXPERIMENTS
MARTIN E. BEYERS (Inst. for Aerospace Research, Ottawa, Canada) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1122-1129. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0682. Previously cited in issue 06, p. 801, Accession no. A91-19410 refs
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A93-31793
BUFFET EXCITATION OF WINGS AT LOW SPEEDS
STEVEN J. ZAN (Inst. for Aerospace Research, Ottawa, Canada) and DAVID J. MAULL (Cambridge Univ., United Kingdom) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1137-1143. Research supported by Department of Trade and Industry of United Kingdom refs
Copyright

Wind-tunnel experiments were undertaken to investigate the unsteady excitation arising from separated flow at low speeds. A series of untapered wing models with a common section chosen to be insensitive to Reynolds number effects was used in the investigation. The models had sweep angles of -20, 0, and 30 deg, and aspect ratios ranging from 6 to 16. The excitation was measured indirectly using wing-root strain gauges and presented in terms of the buffet excitation parameter. The experimental data obtained in this investigation indicate that this parameter attains a common limit under poststall conditions irrespective of wing planform; physical reasons for the limit are discussed. Poststall conditions refer to angles of attack in excess of that at which the lift is maximized. Buffet excitation can attain larger values at lower incidences, and also at high incidences for lower reduced frequencies, which correspond more closely to rigid-body modes.
Author

A93-31801* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON THE INSTABILITY OF HYPERSONIC FLOW PAST A FLAT PLATE
NICHOLAS D. BLACKABY (Manchester Victoria Univ., United Kingdom), STEPHEN J. COWLEY (Cambridge Univ., United Kingdom), and PHILIP HALL (Manchester Victoria Univ., United Kingdom) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 247 Feb. 1993 p. 369-416. Research supported by SERC, Cornell Univ., NASA, et al refs
Copyright

Qualitative features of the inviscid instability characteristics of hypersonic boundary-layer flows over a flat plate are considered. The instability of a viscous hypersonic boundary layer which exists far downstream from the leading edge of the plate. It is shown that the vorticity mode of instability operates on a different lengthscale from that obtained using a Chapman viscosity law. The growth rate predicted by a linear viscosity law is found to overestimate the size of the growth rate. The inviscid instability of the boundary layer near the leading edge interaction zone is discussed focusing on the strong-interaction zone which occurs sufficiently close to the leading edge. The vorticity mode in this regime is found to be unstable.
AIAA

A93-31802 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF GOERTLER VORTICES, WALL COOLING AND GAS DISSOCIATION ON THE RAYLEIGH INSTABILITY IN A HYPERSONIC BOUNDARY LAYER
YIBIN FU and PHILIP HALL (Manchester Victoria Univ., United Kingdom) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 247 Feb. 1993 p. 503-525. Previously announced in STAR as N92-15351 Research supported by SERC refs
(Contract NAS1-18605; AF-AFOSR-89-0042; RTOP 505-90-52-01)
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In a hypersonic boundary layer over a wall of variable curvature, the region most susceptible to Goertler vortices is the temperature adjustment layer sitting at the edge of the boundary layer. This temperature adjustment layer is also the most dangerous site for Reyleigh instability. We investigate how the existence of large amplitude Goertler vortices affects the growth rate of Rayleigh instability. The effects of wall cooling and gas dissociation on this instability are also studied. We find that all these mechanisms increase the growth rate of Rayleigh instability and are therefore destabilizing.
Author

A93-31805
TRANSONIC NOZZLE FLOW OF DENSE GASES
A. KLUWICK (Wien, Technische Univ., Vienna, Austria) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 247 Feb. 1993 p. 661-688. refs
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The paper deals with the flow properties of dense gases in the throat area of slender nozzles. Starting from the Navier-Stokes equations supplemented with realistic equations of state for gases which have relatively large specific heats a novel form of the viscous transonic small-perturbation equation is derived. Evaluation of the inviscid limit of this equation shows that three sonic points rather than a single sonic point may occur during isentropic expansion of such media, in contrast to the case of perfect gases. As a consequence, a shock-free transition from subsonic to supersonic speeds cannot, in general, be achieved by means of a conventional converging-diverging nozzle. Nozzles leading to shock-free flow fields must have an unusual shape consisting of two throats and an intervening antithroat. Additional new results include the computation of the internal thermoviscous structure of weak shock waves and a phenomenon referred to as impending shock splitting. Finally, the relevance of these results to the description of external transonic flows is discussed briefly.
Author

A93-31933
AERODYNAMIC EFFECTS OF AIRCRAFT GROUND DEICING/ANTI-ICING FLUIDS
EUGENE G. HILL and THOMAS A. ZIERTEN (Boeing Commercial Airplane Group, Seattle, WA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 24-34. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0762. Previously cited in issue 07, p. 976, Accession no. A91-21608 refs

A93-31939
FLOWFIELD IN THE VICINITY OF AN F/A-18 VERTICAL FIN AT HIGH ANGLES OF ATTACK
B. H. K. LEE, D. BROWN, F. C. TANG, and M. PLOSENSKI (Inst. for Aerospace Research, Ottawa, Canada) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 69-74. Previously announced in STAR as N92-24865 Research supported by Inst. for Aerospace Research and DND refs

The flowfield behind the vertical fin of a rigid 6 percent scale F/A-18 model was investigated in the Institute for Aerospace Research 1.5 m Trisonic Blowdown Tunnel. The vortical flow structure was studied with the aid of a 49 pressure sensor rake mounted on the model sting. Unsteady pressures were measured from 13 fast response transducers along the horizontal and vertical centerlines of the vortex rake. Spectral, correlation and probability density analyses were carried out. Higher pressure fluctuations in the flowfield were observed on the inboard side of the vertical fin at alpha = 30 deg and 35 deg. At alpha = 25 deg the vortex center was located outboard of the vertical fin. Larger pressure *luctuations were observed on the outboard side of the vertical fin. Above alpha = 30 deg, pressure fluctuations measured with the vortex rake mounted between the vertical fins show quite similar results for M = 0.6 and 0.8. Some representative results from statistical analyses of the unsteady pressures are given at M = 0.6 and alpha = 30 deg. Spectral studies of the vortical flowfiel unsteady pressures show regions where a broad peak with a reduced frequency between 0.45 and 0.5 are detected. Cross correlation analyses indicate the pattern of vorticity to be convected mainly in the free-stream direction. The scale of eddies are no constant at different locations in the flowfields. With the vortex rake mounted behind the vertical fin, the probability densities of the unsteady transducers' signals show that the pressure fluctuations in most of the flowfield can be approximated by a Gaussian distribution. Author

A93-31946* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRANSONIC SHOCK-INDUCED DYNAMICS OF A FLEXIBLE WING WITH A THICK AIRFOIL
ROBERT M. BENNETT, BRYAN E. DANSBERRY, MOSES G. FARMER, CLINTON V. ECKSTROM, DAVID A. SEIDEL, and JOSE A. RIVERA, JR. (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 112-118. AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, 32nd, Baltimore, MD, Apr. 8-10, 1991, Technical Papers. Pt. 3, p. 1919-1928. Previously cited in issue 12, p. 1905, Accession no. A91-32023 refs

A93-31949
NONUNIQUE SOLUTIONS IN UNSTEADY TRANSONIC FLOW
H. S. MURTY (Ottawa Univ., Canada) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 129-131. Previously announced in STAR as N92-24872 refs

The purpose of the present work was to study the occurrence of nonunique solutions in unsteady transonic flows. In this study, a full potential unsteady code was developed and applied to the analysis of flows past NACA 0012 and NACA 64A006 airfoils. Wherea previous studies provided examples of nonunique solutions using the small disturbance potential flow model, the full potential flow model could not verify those solutions. It is not the neglect of shock wave generated vorticity and entropy that is responsible for the nonunique phenomena as all potential flow models share the assumption of isentropic flow. It is possible that the variation in modeling the wake boundary conditions may affect the solution obtained. Author

A93-31951
COMPUTATIONAL METHOD FOR MATCHING AERODYNAMIC EXPERIMENTAL DATA WITH THEORETICAL INFLUENCE MATRICES
CLAUDIO PONZI (Alenia S.p.A., Rome, Italy) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 133-135. refs

A procedure is developed which finds minimum changes in an analytical aerodynamic influence matrix to make it exactly agree with a set of measured pressure coefficients. This procedure is suitable for application to large matrices where the number of linearly independent sets of available pressure coefficient data is smaller than the total number of panels of the aerodynamic discretization. Provisions for overcoming nonsimilarity between the experimental and the theoretical aerodynamic grid as well as aeroelastic effects on the experimental model are straightforward. AIAA

A93-31952* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL FLOWFIELDS FOR STATIC TESTING OF POWERED HYPERSONIC AFTBODY MODELS
LAWRENCE D. HUEBNER (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 135-137. refs

Two-dimensional CFD analyses are presented related to the ground testing of hypersonic, air-breathing models which feature scramjet exhaust flow simulation. CFD analysis indicates that it is possible to test aftbody powered hypersonic airbreather configurations in a static, pumped-down environment to obtain aftbody aerodynamic performance data. AIAA

A93-31953
FORMULATION OF DESIGN ENVELOPE CRITERION IN TERMS OF DETERMINISTIC SPECTRAL PROCEDURE
J. G. JONES (Royal Aerospace Establishment, Farnborough, United Kingdom) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 137-139. Previously announced in STAR as N90-25953 refs

An existing design envelope approach to meeting aircraft limit load requirements for flight in continuous turbulence, using power spectral methods, is reformulated in a manner which makes no distinction between linear and non-linear aircraft response. Computational techniques for implementing the new procedure in applications to nonlinear aircraft are discussed and compared with existing simulation methods. Author

A93-31955
VISCOUS SUBSONIC FLOW COMPUTATION FOR WINGS WITH FLAPS FOR HIGH-LIFT
H. N. V. DUTT (National Aeronautical Lab., Bangalore, India) and K. JACOB (DLR, Goettingen, Germany) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 141-143. refs

Jacob's (1987) method is extended to the analysis of multielement wings comprising multicomponent airfoils at high lift. The approach considered includes a model for ground effect, compressibility, trailing-edge separation, and curved basic flow. First attempts to validate the method by comparing computed results with measurements are reported; within the limits of the assumptions used, the theoretical results compare well with those

of experiments and the computing time requirements are modest. AIAA

A93-31956
TRANSONIC FLUTTER ANALYSIS USING TIME-LINEARIZATION AERODYNAMICS
Y. S. WONG (Alberta Univ., Edmonton, Canada), B. H. K. LEE (National Research Council of Canada, Ottawa), and H. S. MURTY (Ottawa Univ., Canada) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 144, 145. Research supported by DND, Inst. for Aerospace Research, and NSERC refs
Copyright

The 3D time-linearized small-disturbance unsteady transonic flow code UST3D was validated for the F5 and ONERA M6 wings. Flutter analysis performed with the IAR flutter analysis program using UST3D for the AGARD 445.6 wing demonstrates fairly good agreement with experimental data. The time linearization method is shown to be more efficient than the time integration approach. AIAA

A93-31960
EFFECT OF VISCOUS DRAG ON OPTIMUM SPANWISE LIFT DISTRIBUTION
KAMRAN ROKHSAZ (Wichita State Univ., KS) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 152-154. Abridged. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992, AIAA Paper 92-0287. Previously cited in issue 09, p. 1349, Accession no. A92-25740 refs
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A93-31961
PAN AIR ANALYSIS OF SIMPLY CONNECTED CONTROL SURFACE DEFLECTIONS
SETH A. MOYER (U.S. Navy, Naval Air Warfare Center, Warminster, PA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 154-156. refs

Several approaches to modeling simply connected flaps with PAN AIR have been studied. Relative to to geometric approaches, the boundary condition approach is shown to do a very good job of modeling the upwash and sidewash flowfields. In absolute terms, compared with experimental data, this approach matches upwash well and sidewash to various levels, depending on flight condition. This method requires no geometry changes to a properly paneled baseline model in order to model flap seetings; analysis of many different flap configurations thus becomes possible in a short time period. AIAA

A93-31977
MULTIBLOCK IMPLICIT TOTAL VARIATION DIMINISHING SOLUTION OF HIGH-SPEED INTERNAL FLOWS
F. GRASSO and M. MARINI (Roma I, Univ., Rome, Italy) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 255-262. refs
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In this article a multiblock finite-volume technique with a second-order total variation diminishing spatial discretization and an efficient implicit time integration has been developed to simulate complex internal flows at high Mach numbers. This method employs a lower and upper approximate factorization of the implicit operator with symmetric successive over relaxation sweeps. In the presence of multiblocks, an asynchronous-interface treatment has been devised for an accurate coupling of the blocks. A detailed validation by comparison of the computed results with experiments has shown the capabilities of the method to resolve complex high-speed internal flows and to simulate the influence of bleed as a boundary-layer control system. Author

A93-31978
QUASI-THREE-DIMENSIONAL NONREFLECTING BOUNDARY CONDITIONS FOR EULER EQUATIONS CALCULATIONS
ANDRE P. SAXER and MICHAEL B. GILES (MIT, Cambridge, MA) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 263-271. AIAA Computational Fluid Dynamics Conference, 10th, Honolulu, HI, June 24-27, 1991, Technical Papers, p. 845-857. Previously cited in issue 17, p. 2851, Accession no. A91-40775 Research supported by Rolls-Royce, PLC refs
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A93-31979
NEW TWO-GRID ACCELERATION METHOD FOR UNSTEADY NAVIER-STOKES CALCULATIONS
L. HE (Cambridge Univ., United Kingdom) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 272-280. Research supported by Rolls-Royce, PLC refs
Copyright

A quasi-three-dimensional time-marching Navier-Stokes method for calculating unsteady viscous flows in turbomachines is presented. A major feature of the present work is that the time-step limitation in the Navier-Stokes solutions suffered by all explicit time-marching methods is effectively relaxed by using a time-consistent two-grid method. The spatial accuracy is subject to the basic fine mesh, while the coarse mesh, on which the temporal accuracy is guaranteed, is locally applied to the near wall and wake regions to increase the allowable time-step length. The loss of the time accuracy on the basic fine mesh can be easily controlled by choosing a suitable grid size of the coarse mesh according to the wavelength of physical unsteadiness to be dealt with. This two-grid method has been compared with the implicit residual-averaging method and the direct time-marching method for transonic oscillating cascade flow. Numerical examples for a low-speed oscillating airfoil flow at a dynamic stall condition and a transonic airfoil flow with a self-excited shock oscillation are also presented, in which an increase in the time-step length by a factor of 20 has been achieved. Author

A93-31980
ROTATING STALL PERFORMANCE AND RECOVERABILITY OF A HIGH-SPEED 10-STAGE AXIAL FLOW COMPRESSOR
WILLIAM W. COPENHAVER (USAF, Wright Lab., Wright-Patterson AFB, OH) and THEODORE H. OKIISHI (Iowa State Univ. of Science and Technology, Ames) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 281-292. AIAA, ASME, SAE, and ASEE, Joint Propulsion Conference, 25th, Monterey, CA, July 10-13, 1989, AIAA Paper 89-2684. Previously cited in issue 20, p. 3084, Accession no. A89-47014 Research supported by USAF refs

A93-31981
WAKE MIXING AND PERFORMANCE OF A COMPRESSOR CASCADE WITH CRENULATED TRAILING EDGES
S. J. DECOOK, P. I. KING, and W. C. ELROD (USAF, Inst. of Technology, Wright-Patterson AFB, OH) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 293-300. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992, AIAA Paper 92-3188. Previously cited in issue 20, p. 3472, Accession no. A92-48800 refs

A93-31984
DESIGNING HYPERSONIC INLETS FOR BOW SHOCK LOCATION CONTROL
MARK J. LEWIS (Maryland Univ., College Park) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 313-321. Research supported by Charles Stark Draper Lab., Inc refs
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The desire to match the bow shock of a hypersonic vehicle to the lip of the engine cowl provides for a design constraint on the hypersonic forebody. For inviscid flow, it is shown that there is one particular wedge angle which provides for shock matching which is insensitive to steady-state changes in vehicle angle of attack, though it is not possible to match against changes in flight Mach number. The angle-of-attack sensitivity of a hypersonic boundary layer makes this matching process more difficult. Design

rules for cowl matching with secondary shocks are presented, though it is shown that it is never possible to fix them against changes in angle of attack. Author

A93-32056
THREE-DIMENSIONAL BOUNDARY LAYER AND VORTEX WAKE OVER A CONE AT HIGH ANGLE OF ATTACK - STUDY OF ASYMMETRIES
J.-L. MENET, B. MENART, and C. TOURNIER (Valenciennes Univ., France) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 4 Feb. 1993 p. 224-232. refs
Copyright

An experimental investigation of the flow over a one at a large angle of attack is reported. First, the study was focused on the wall shear stress measurement, including the localization of the separation. Secondly, the mean flow field in the whole wake of the cone was measured, as well as the velocity fluctuations. Results indicate that the separation and the fluctuations are asymmetrical in a certain way, whereas the mean flow field is approximately symmetrical. Finally, the different parts of the flow can be easily determined using vorticity calculations. Author

A93-32062* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECTS OF SMALL CHANGES IN INITIAL CONDITIONS ON MIXING LAYER THREE-DIMENSIONALITY
M. W. PLESNIAK (Stanford Univ., CA), J. H. BELL (NASA, Ames Research Center, Moffett Field, CA), and R. D. MEHTA (Stanford Univ.; NASA, Ames Research Center, Moffett Field, CA) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 4 Feb. 1993 p. 286-288. refs
(Contract NSF MSM-88-15670; NCC2-55)
Copyright

The effects of relatively small changes in the initial conditions of the development of the 3D structure of a plane mixing layer originating from laminar boundary layers were experimentally studied. It is found that, while the exact shapes and positions of the streamwise vortex structures are not the same for the two initial conditions, their overall distribution, reorganization, and decay are very similar. The results likely that while some of the specific details of the streamwise vortex structure may be facility-dependent, a relatively strong structure which produces significant three-dimensionality should form in all mixing layers originating from laminar boundary layers. After some initial readjustments, the structure will appear in the form of counterrotating pairs of streamwise vortices which in the mean, grow with the mixing layer and decay in strength. The results also serve to warn that small changes in initial conditions may significantly affect the Reynolds stress distributions in the near field. AIAA

A93-32154
GAS DYNAMICS OF JET ENGINE COMPONENTS [GAZODINAMIKA ELEMENTOV VRD]
S. M. SHLIAKHTENKO, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 100 p. In Russian. For individual items see A93-32155 to A93-32172
Copyright

The papers presented in this volume provide an overview of theoretical and experimental research related to the gas dynamics of jet engine components. Topics discussed include calculation of the parameters of a supersonic gas-droplet jet, numerical modeling of the combustion of hydrocarbon fuels, a method for calculating a turbulent reacting nonisobaric jet, and a parametric study of subsonic flow in a duct with a sudden expansion. Papers are also presented on total pressure losses in a centrifugal stage diffuser, an engineering method for calculating flows in turbine cascades with variable meridional contours of the flow path, and mathematical modeling of heat exchangers in the system of a combination engine. AIAA

A93-32155
A SHOCK WAVE AHEAD OF A FLUID JET IN A SUPERSONIC CROSS STREAM [UDARNAIA VOLNA PERED STRUEI ZHIDKOSTI V SNOSIASHCHEM SVERKHZVUKOVOM POTOKE]
S. I. BARANOVSKII and D. M. DAVIDENKO *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 4-9. In Russian. refs
Copyright

A method for calculating the shape of shock waves ahead of underexpanded gas jets (Schetz, 1970) is extended to the case of the injection of a fluid jet normal to the supersonic flow. An analysis of the results obtained indicates that the deflection of the shock wave in front of the jet remains practically unchanged for different values of the relative jet head. Good agreement is obtained between the calculated and experimental shock wave profiles. AIAA

A93-32156
CALCULATION OF THE PARAMETERS OF A SUPERSONIC GAS-DROPLET JET [RASCHET PARAMETROV SVERKHZVUKOVOI GAZOKAPEL'NOI STRUI]
A. I. TURISHCHEV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 9-12. In Russian. refs
Copyright

A supersonic submerged gas-droplet jet is modeled numerically using a two-dimensional two-velocity continuum model. The droplets are assumed to be monodisperse, with the droplet size being equal to the mean Sauter diameter; interphase heat and mass transfer is not taken into account. The problem is reduced to a generalized parabolic equation, which is solved by a second-order finite difference method. The method proposed here is sufficiently simple and can be extended to the case of supersonic flows with heat and mass transfer and combustion. AIAA

A93-32159
A METHOD FOR CALCULATING A REACTING TURBULENT NONISOBARIC JET [METODIKA RASCHETA TURBULENTNOI REAGIRUIUSHCHEI NEIZOBARICHESKOI STRUI]
V. A. PERMINOV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 19-25. In Russian. refs
Copyright

An algorithm for computing supersonic turbulent nonisobaric jets is proposed which makes it possible to calculate nonisobaric jets with a pressure differential up to 25 without using damping terms. The approach is based on solving simplified Navier-Stokes equations using a finite difference method combining the MacCormack's scheme and its analog with counterflow differences. The combination of two difference schemes significantly reduces the dispersion error. The method is recommended for calculating combustion in supersonic flow. AIAA

A93-32160
A PARAMETRIC STUDY OF SUBSONIC FLOW IN A DUCT WITH A SUDDEN EXPANSION [PARAMETRICHESKOE ISSLEDOVANIE DOZVUKOVOGO TECHENIIA V KANALE S VNEZAPNYM RASSHIRENIEM]
O. V. SPIRIDONOV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 25-28. In Russian. refs
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Subsonic nonreacting flow in an axisymmetric duct with a sudden expansion is investigated using an implementation of a method for solving a full system of Navier-Stokes equations based on the integration of the equations over control volumes around the nodes of the finite difference grid. It is found that, for a constant duct radius ratio, the dimensionless velocity profiles are practically self-similar and depend only slightly on the initial velocity. The results of the study provide a way to estimate the length of the recirculation zone in engineering calculations of subsonic flows in ducts with a sudden expansion. AIAA

A93-32161
MODELING OF UNSTEADY SUPERSONIC FLOWS USING FULL NAVIER-STOKES EQUATIONS [MODELIROVANIE NESTATSIONARNYKH SVERKHZVUKOVYKH TECHENII NA OSNOVE POLNYKH URAVNENII NAV'E-STOKSA]
A. S. VOINOVSKII and A. S. NADVORSKII *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 29-35. In Russian. refs

A method for solving full unsteady Navier-Stokes equations is presented which has certain advantages over other existing methods and is applicable to a wider class of flows. The method uses an absolutely stable second-order finite difference scheme and is implemented in arbitrary curvilinear coordinates. The boundary conditions are specified physically using the method of characteristics. The proposed method for the numerical integration of Navier-Stokes equations has been implemented in a software module written in FORTRAN. Applications of the method are illustrated by examples. AIAA

A93-32162
EFFECT OF THE CASCADE DENSITY ON THE LAG ANGLE AND THE FLOW TURN ANGLE IN A PLANE COMPRESSOR CASCADE [VLIIANIE GUSTOTY RESHETKI NA VELICHINU UGLA OTSTAVANIIA I POVOROTA POTOKA V PLOSKOI KOMPRESSORNOI RESHETKE]
V. M. ZADIABIN and A. A. MITROFANOV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 35-40. In Russian. refs

Experimental data are presented on the effect of the cascade density on the lag angle and the flow turn angle in plane compressor cascades in the self-similar (with respect to the Reynolds number) region at optimal angles of attack and subsonic Mach numbers at the inlet. The data indicate that an increase in the cascade density, to a certain point only, leads to a decrease in the flow lag angle. The effect of a decrease in the flow turn angle in the cascade is also observed at large cascade densities. AIAA

A93-32163
TOTAL PRESSURE LOSSES IN A CENTRIFUGAL STAGE DIFFUSER [POTERI POLNOGO DAVLENIIA V DIFFUZORE TSENTROBEZHNOI STUPENI]
IU. N. KOLESNIKOV and L. A. IARKOVETS *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 40-42. In Russian. refs

In order to refine an approximation expression for the total pressure retention coefficient as a function of the Mach number and the diffuser expansion ratio, total pressure losses in a bladed diffuser were calculated using wind-tunnel data for plane diffusers. Calculation results are presented for expansion ratios of 3.79-4.19. The results of the study have made it possible to improve the existing method for determining the total pressure retention coefficient. AIAA

A93-32164
AN EXPERIMENTAL STUDY OF LOSSES IN ACTIVE MICROTURBINE CASCADES [EKSPERIMENTAL'NOE ISSLEDOVANIE POTER' V AKTIVNYKH RESHETKAKH MIKROTURBIN]
B. A. KRYLOV and S. A. GUSAROV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 42-46. In Russian. refs

Active annular microturbine cascades were investigated experimentally as part of a systematic study of microturbines. The tests were carried out using a recently developed gasdynamic testing bench. An analysis of the experimental data yields expressions relating losses in annular active microturbine cascades to the geometrical parameters of the cascade for constant normalized velocity. AIAA

A93-32166
AN ENGINEERING METHOD FOR CALCULATING FLOW IN TURBINE CASCADES WITH VARIABLE MERIDIONAL CONTOURS OF THE FLOW PATH [INZHENERNAIA METODIKA RASCHETA TECHENIIA V TURBINNYKH RESHETKAKH S VAR'IRUEMOI FORMOI MERIDIONAL'NYKH OBVODOV PROTOCHNOI CHASTI]
A. K. SITNIKOV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 54-58. In Russian.

A simplified procedure for calculating flows in turbine cascades is proposed which is suitable for engineering calculations at the stage of the preliminary selection of the profile and meridional contours of the flow path of turbine cascades. The assumptions that make it possible to significantly simplify the computation algorithm are based on results of experimental studies of straight and annular cascades with various degrees of expansion of the meridional contours of the flow path. A comparison with results obtained by a more exact method and with experimental results demonstrates that the method proposed here is sufficiently accurate for practical applications. AIAA

A93-32168
FLOW NEAR THE BOUNDING SURFACES OF THE BLADE PASSAGE OF A STRAIGHT NOZZLE CASCADE WITH A MERIDIONAL SECTION EXPANSION [TECHENIE VBLIZI OGRANICHIVAIUSHCHIKH POVERKHNOSTEI MEZHLOPATOCHNOGO KANALA PRIAMOI SOPLOVOI RESHETKI S RASKRYTIEM MERIDIONAL'NOGO SECHENIIA]
N. V. ESHCHENKO and V. I. KUZNETSOV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 62-66. In Russian.

Results of tests conducted on straight nozzle cascades with constant and expanding meridional sections are presented. Isentropic velocity distributions on the profile surface in the blade passage, based on static pressure measurements are presented. To a first approximation, it is found that the mean velocity directly follows changes in the height of the blade passage. Some differences between the flows in the two types of cascades are briefly discussed. AIAA

A93-32175
A METHOD FOR CALCULATING THE SPATIAL POSITION OF THE VORTEX WAKE BEHIND COAXIAL HELICOPTER ROTORS [METOD RASCHETA PROSTRANSTVENNOGO POLOZHENIIA VIKHREVOGO SLEDA ZA NESUSHCHIMI VINTAMI VERTOLETA SOOSNOI SKHEMY]
A. D. MASLOV *In* Problems in the design of helicopter rotors Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 11-17. In Russian. refs

A method for determining the position of the vortex wake behind coaxial rotors is proposed which uses a wake model in the form of two convoluted vortex cords. To illustrate the practical application of the convoluted vortex wake model, the model is used to calculate the motion trajectories of droplets of a fluid sprayed from a Ka-126 helicopter flying at 60 km/hr at an altitude of 8.5 m. It is shown that, due to the induction effect of the coaxial rotor, the droplet trajectories become looped and depend to a large degree on the droplet diameter. AIAA

A93-32177
EXPERIMENTAL STUDIES OF AIR FLOW IN THE CHANNEL OF A CIRCULATION-CONTROL ROTOR BLADE [EKSPERIMENTAL'NYE ISSLEDOVANIIA TECHENIIA VOZDUKHA V TRAKTE LOPASTI NESUSHCHEGO VINTA S UPRAVLIAEMOI TSIRKULIATSIEI]
A. D. KOZACHUK *In* Problems in the design of helicopter rotors Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 26-31. In Russian. refs

In an earlier study (Kozachuk, 1987), a mathematical model was proposed which describes air flow in the control channel of a circulation-control rotor. The model uses certain simplifying assumptions including the substitution of a one-dimensional steady flow for a three-dimensional unsteady flow. The objective of the experiment reported here was to test and, if necessary, to refine the model. The results obtained validate the static method of calculating air flow in the control channel of a circulation-control rotor. The angles of air flow out of the slot nozzle are determined for different channel geometries. AIAA

A93-32217
SYNTHESIS OF THE MEAN-OPTIMAL PROGRAMMED CONTROL OF FLIGHT VEHICLE BRAKING WITH AN UNFIXED MOMENT OF TERMINATION [SINTEZ OPTIMAL'NOGO V SREDNEM PROGRAMMNOGO UPRAVLENIIA TORMOZHENIEM LA S NEFIKSIROVANNYM MOMENTOM OKONCHANIIA]
A. V. PANTELEEV and N. E. DMITRIEVA *In* Optimization of the structures and parameters of the automatic control systems of flight vehicles Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 51-58. In Russian. refs
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The deceleration of a flight vehicle is considered which consists of the stage of aerodynamic braking using the lift force and the stage of soft landing using jet engines. The moment at which the process terminates is determined by the conditions of soft landing and is not fixed. The problem of determining the optimal programmed control that minimizes the mean functional value is solved using relations following from the corresponding sufficient conditions of optimality in the mean for the control of groups of trajectories in the case of incomplete information. An approximate solution algorithm is proposed which represents an extension of the approach developed for the problem of trajectory control with the fixed moment of process termination. The efficiency of the algorithm is illustrated by numerical results. AIAA

A93-32287 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECT OF NOSE SHAPE ON THREE-DIMENSIONAL STREAMLINES AND HEATING RATES
BASIL HASSAN, FRED R. DEJARNETTE (North Carolina State Univ., Raleigh), and E. V. ZOBY (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 30, no. 1 Jan.-Feb. 1993 p. 69-78. AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991, AIAA Paper 91-5032. Previously cited in issue 05, p. 674, Accession no. A92-17822 Research supported by USAF and U.S. Navy refs
(Contract NAGW-1072; NCC1-1002)
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A93-32401* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
QUASICONICAL FLOWFIELD STRUCTURE OF THE THREE-DIMENSIONAL SINGLE FIN INTERACTION
DOYLE D. KNIGHT, DIAS BADEKAS (Rutgers Univ., New Brunswick, NJ), C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA), and GARY S. SETTLES (Pennsylvania State Univ., University Park) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2809-2816. Research sponsored by NASA refs
(Contract AF-AFOSR-86-0266; AF-AFOSR-89-0315)
Copyright

A series of conical and three-dimensional computations have been performed for the swept oblique shock wave/turbulent boundary-layer interaction generated by a 20-deg sharp fin at Mach 4 and freestream Reynolds number of 2.18 x 10 exp 5 based on the incoming boundary-layer thickness. The Reynolds-averaged compressible Navier-Stokes equations are employed with turbulence incorporated using the Baldwin-Lomax and Jones-Launder models. The computed results are basically similar for both turbulence models and display general agreement with experimental data for surface pressure and surface flow direction, although underestimating the size of the primary vortex. The computed three-dimensional flowfield displays quasiconical behavior of the surface pressure, surface flow direction, and flowfield contours of static pressure, density, and Mach number over the extent of the computational domain except for an inception region near the fin leading edge. Certain features of the flowfield model are not observed in the computations, namely, a 'normal' shock near the attachment line, transonic shocklets in the expansion region, and secondary separation. The absence of these features in the computation is believed to be indirectly attributable to limitations in the turbulence models. Author

A93-32402* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DEVELOPMENT OF THE WAKE OF AN AIRFOIL WITH RIBLETS
J. M. CARAM (Texas A & M Univ., College Station; NASA, Johnson Space Center, Houston) and A. AHMED (Texas A & M Univ., College Station) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2817, 2818. Abridged. AIAA Applied Aerodynamics Conference, 7th, Seattle, WA, July 31-Aug. 2, 1989, Technical Papers, p. 307-321. Previously cited in issue 21, p. 3251, Accession no. A89-47658 refs
Copyright

A93-32405
COUPLED EULER/BOUNDARY-LAYER METHOD FOR NONEQUILIBRIUM, CHEMICALLY REACTING HYPERSONIC FLOWS
S. WUETHRICH and M. L. SAWLEY (Lausanne, Ecole Polytechnique Federale, Switzerland) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2836-2844. Research supported by Dassault Aviation and Commission Suisse pour l'Encouragement de la Recherche Scientifique refs
Copyright

A coupled Euler/boundary-layer method to calculate hypersonic flows in chemical nonequilibrium is described. Air chemistry is modeled by five species and a chemical scheme of 17 reactions. The coupled Euler/boundary-layer method consists of the successive solution of two sets of equations of increasing order in Re exp -1/2 (where Re is the Reynolds number). It is shown that, with the inclusion of second-order terms, a good matching of the calculated profiles at the interface between the inviscid and viscous regions can be obtained for both the chemical and thermodynamical properties. Second-order effects play a major role in determining the surface coefficients for high Mach number flows. For hypersonic flow over a sphere, excellent agreement is shown between the calculated of the surface coefficients and those determined from experiments. Author

A93-32407
STREAMWISE EVOLUTION OF A SQUARE JET CROSS SECTION
W. R. QUINN (St. Francis Xavier Univ., Antigonish, Canada) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2852-2857. DGLR/AIAA Aeroacoustics Conference, 14th, Aachen, Germany, May 11-14, 1992, Proceedings. Vol. 1, p. 287-294. Previously cited in issue 05, p. 712, Accession no. A93-19158 Research supported by NSERC refs
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A93-32409
CROSSFLOW AERODYNAMIC CHARACTERISTICS OF A NONCIRCULAR CYLINDER WITH AND WITHOUT STRAKES
BANDU N. PAMADI (Vigyan Research Associates, Inc., Hampton, VA) and B. H. LAXMANA GOWDA (Indian Inst. of Technology, Madras, India) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2864-2870. AIAA Applied Aerodynamics Conference, 6th, Williamsburg, VA, June 6-8, 1988, Technical Papers, p. 582-592. Previously cited in issue 16, p. 2597, Accession no. A88-40761 refs
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A93-32426
CORRELATION OF TYPE III TURBULENT SHOCK INTERACTION HEATING DATA ON A HEMISPHERE
STEVEN A. LUTZ (Johns Hopkins Univ., Laurel, MD) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2973, 2974. refs
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Supersonic turbulent jet impingement studies are examined for suitable scaling parameters; since pressure is closely related to heating, normalized heating data should be collapsed by using the same distance scaling factor. This hypothesis is here tested by considering the type III interaction hemisphere heating distribution data from Keyes (1973). The width of the attaching shear layer is computed under the assumption of turbulent free shear layer mixing from the shock intersection point to the hemisphere surface. AIAA

A93-32427
EXAMPLE OF SECOND-MODE INSTABILITY DOMINANCE AT A MACH NUMBER OF 5.2
KENNETH F. STETSON and ROGER L. KIMMEL (USAF, Wright Lab., Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2974-2976. refs

Experimental results are presented which confirm that the second-mode disturbances are the major such phenomena in the boundary layer of a cone at local Mach number of 5.2, where freestream Mach number is 6.0. A plausible explanation is on this basis given to the results of Kendall (1975), who found no evidence to substantiate the expected dominance of second-mode disturbances. AIAA

A93-32428* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DOWNSTREAM INFLUENCE SCALING OF TURBULENT FLOW PAST EXPANSION CORNERS
FRANK K. LU and KUNG-MING CHUNG (Texas Univ., Arlington) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2976, 2977. refs
(Contract NAG1-891)
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Previous studies of the high-speed viscous inviscid interaction between a turbulent boundary layer and an expansion at a convex corner have noted that surface pressure decreases toward the downstream inviscid value yielded by a Prandtl-Meyer expansion. A downstream influence on the corner is presently identified which is based on the mean surface pressure distribution; a scaling law is proposed for this distance. AIAA

A93-32432* National Aeronautics and Space Administration, Washington, DC.
COMPARISON OF NUMERICAL OBLIQUE DETONATION SOLUTIONS WITH AN ASYMPTOTIC BENCHMARK
MATTHEW J. GRISMER and JOSEPH M. POWERS (Notre Dame Univ., IN) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2985-2987. Research supported by Univ. of Notre Dame and NASA refs
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In order to have confidence in a numerical method, the verification of its reproduction of known benchmark analytic solutions for simple model problems is of great importance. Attention is presently given to a novel benchmarking procedure for numerical models of high speed, reactive 2D flows. The procedure is illustrated by comparing asymptotic and numerical solutions for oblique detonations in which an attached oblique shock is followed by an exothermic reaction with a thick reaction zone. AIAA

A93-32552
COOLING AND ROUGHNESS EFFECTS ON TRANSITION ON NOZZLE THROATS AND BLUNT BODIES
ANTHONY DEMETRIADES (Montana State Univ., Bozeman) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 29, no. 4 July-Aug. 1992 p. 432-436. refs
(Contract F04701-80-C-0032)
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Observations of boundary-layer transition in a supersonic wind-tunnel nozzle throat were made in the region where the local Mach number increased from 0.4 to 2. The wall temperature ranged from adiabatic to 0.66 times the stagnation temperature, and its surface was roughened with random sand-grain, weave-type, and wire-screen roughness. It was found that wall cooling accelerates transition markedly regardless of surface conditions and that for a given height the random sand-type roughness is generally the most effective transition trigger. Transition location was much less sensitive to weave-type roughness and its orientation, although a drastic transition Reynolds number decrease was noted when the weave wavelength increased. With the roughness small or absent, phenomena involving boundary-layer relaminarization were observed. A substantial portion of these data cannot be accounted for by existing blunt-body boundary-layer transition correlations. Author

A93-32701
REVIEW OF UNSTEADY AERODYNAMIC METHODS FOR TURBOMACHINERY AEROELASTIC AND AEROACOUSTIC APPLICATIONS
JOSEPH M. VERDON (United Technologies Research Center, East Hartford, CT) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 235-250. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992, AIAA Paper 92-0011. Previously cited in issue 08, p. 1167, Accession no. A92-23730 Research supported by United Technologies Corp refs
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A93-32702* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGHER-ORDER ACCURACY FOR UPWIND METHODS BY USING THE COMPATIBILITY EQUATIONS
PETER M. GOORJIAN and SHIGERU OBAYASHI (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 251-256. AIAA Computational Fluid Dynamics Conference, 10th, Honolulu, HI, June 24-27, 1991, Technical Papers, p. 181-189. Previously cited in issue 17, p. 2847, Accession no. A91-40718 refs
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A93-32706
MIXING ENHANCEMENT IN COMPRESSIBLE MIXING LAYERS - AN EXPERIMENTAL STUDY
E. M. FERNANDO (Quest Integrated, Inc., Kent, WA) and S. MENON (Georgia Inst. of Technology, Atlanta) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 278-285. AIAA, Fluid Dynamics, Plasma Dynamics and Lasers Conference, 22nd, Honolulu, HI, June 24-26, 1991, AIAA Paper 91-1721. Previously cited in issue 18, p. 3056, Accession no. A91-43612 refs
(Contract F33615-88-C-2904; F33615-89-C-2931)
Copyright

A93-32709
EFFECTS OF SWEEPBACK ON UNSTEADY SEPARATION IN MACH 5 COMPRESSION RAMP INTERACTIONS
M. E. ERENGIL and D. S. DOLLING (Texas Univ., Austin) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 302-311. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992, AIAA Paper 92-0430. Previously cited in issue 12, p. 1900, Accession no. A92-31663 refs
(Contract AF-AFOSR-86-0112; DAAL03-91-G-0023)
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A93-32712
HYSTERESIS EFFECTS ON WIND TUNNEL MEASUREMENTS OF A TWO-ELEMENT AIRFOIL
KASIM BIBER and GLEN W. ZUMWALT (Wichita State Univ., KS) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p.

326-330. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992, AIAA Paper 92-0267. Previously cited in issue 09, p. 1347, Accession no. A92-25723 refs
Copyright

A93-32721
INDUCED DRAG OF WINGS OF FINITE ASPECT RATIO
F. LAM (Cambridge Univ., United Kingdom) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 396-398. Research supported by British Aerospace, PLC and Croucher Foundation refs
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The present lifting-line theory for inviscid flow takes into account the mean effect of trailing vortex sheet roll-up with downstream distance. Calculations based on the wing-wake model show that, for a representative load distribution, the rollup of the sheet within a downstream distance comparable to the wing span results in lower induced drag, relative to the value yielded by Prandtl's classical lifting-line theory; this is due to the variation in downwash velocity field that is a consequence of the rolled-up line vortices. AIAA

A93-33109
UNSTEADY AERODYNAMIC RESPONSES OF MISTUNED CASCADES TO INCOMING WAKES (MISTUNING OF STAGGER ANGLE)
KEN-ICHI FUNAZAKI (Iwate Univ., Morioka, Japan) JSME International Journal, Series B: Fluids and Thermal Engineering (ISSN 0914-8817) vol. 36, no. 1 Feb. 1993 p. 66-73. refs
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Unsteady aerodynamic responses of a mistuned cascade subjected to incoming wakes from an upstream cascade are investigated in this study, where the extended Nishiyama-Funazaki method is employed. Numerical calculations are made, focusing on the effects of stagger angle mistuning of the cascade. It is accordingly found that there is some possibility of reducing wake-induced unsteady forces by controlling stagger angles without the severe expense of cascade performance deterioration. In addition, intense correlation between unsteady lifts and the corresponding steady lifts in the case of in-phase incoming wake conditions is observed. Author

A93-33113
THE AERODYNAMIC CHARACTERISTICS OF A CIRCULAR CYLINDER WITH TANGENTIAL BLOWING IN UNIFORM SHEAR FLOWS
TSUTOMU HAYASHI, FUMIO YOSHINO, and RYOJI WAKA (Tottori Univ., Japan) JSME International Journal, Series B: Fluids and Thermal Engineering (ISSN 0914-8817) vol. 36, no. 1 Feb. 1993 p. 101-112. refs
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Tangential blowing on a circular cylinder is used to control or prevent boundary layer separation to generate lift by increasing the circulation around the cylinder. The effect of shear parameters, the location of the slot, and the sign of the velocity gradient on the aerodynamic characteristics of a circular cylinder with tangential blowing in uniform shear flows are studied. The contributions of various features, such as the stagnation point, to the lift and drag are discussed in detail and evaluated for individual components. The results are important for the development of high-lift devices and for the improving the efficiency of film cooling of gas turbine blades. AIAA

A93-33326
PROBLEMS IN THE AERODYNAMICS OF FLIGHT VEHICLES AND THEIR COMPONENTS [VOPROSY AERODINAMIKI LETATEL'NYKH APPARATOV I IKH CHASTEI]
IU. A. RYZHOV, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 88 p. In Russian. For individual items see A93-33327 to A93-33340
Copyright

Recent theoretical and experimental research related to the aerodynamics of flight vehicles and their components is reviewed with emphasis on the work performed at the Moscow Aviation Institute. Topics discussed include the aerodynamic characteristics of a sweptforward-wing aircraft model in unsteady motion at large angles of attack in subsonic flow, the use of triangular elements in panel methods for calculating flow past flight vehicles, calculation of the turbulent viscosity coefficient, and calculation of subsonic flow of a gas past an airfoil. Papers are also presented on pressure fluctuations on a delta wing in incompressible flow, an experimental study of a composite supersonic jet, and a method for the numerical solution of the kinetic equation of drop coalescence and fractionation. AIAA

A93-33327
AERODYNAMIC CHARACTERISTICS OF A SWEPTFORWARD-WING AIRCRAFT MODEL IN UNSTEADY MOTION AT LARGE ANGLES OF ATTACK IN SUBSONIC FLOW [AERODINAMICHESKIE KHARAKTERISTIKI MODELI SAMOLETA S KRYLOM OBRATNOI STRELOVIDNODSTI PRI NEUSTANOVIVSHEMSIA DVIZHENII NA BOL'SHIKH UGLAKH ATAKI V DOZVUKOVOM POTOKE]
A. L. KIR'IANOV, G. S. SADEKOVA, and A. N. ZHUK *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 4-11. In Russian. refs
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Results of experimental parametric studies of the aerodynamic characteristics of an aircraft with a sweptforward wing under conditions of unsteady motion are reported. The tests were carried out using an improved version of the free vibration method for angles of attack up to 43 deg and low subsonic velocities (30 m/s). Test results are presented in the form of the angle of attack dependences of the pitch moment and normal force coefficients and also relations characterizing changes in the normal force coefficients under conditions of unsteady motion in comparison with steady motion. AIAA

A93-33329
THE USE OF TRIANGULAR ELEMENTS IN PANEL METHODS FOR CALCULATING FLOW PAST FLIGHT VEHICLES [ISPOL'ZOVANIE TREUGOL'NYKH ELEMENTOV V PANEL'NYKH METODAKH RASCHETA OBTEKANIIA LA]
IU. S. SOROKIN *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 18-24. In Russian. refs
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The concept of triangular elements is used in conjunction with a panel method for calculating flow past a wing at subsonic velocities. The problem of steady subsonic potential flow of an ideal gas past a wing is solved using a linear formulation; the wing surface is partitioned into N triangular elements, and a system of linear algebraic equations is obtained to solve for the potentials of the perturbed velocities at the node points. It is then shown that the formulation for the wing can be readily extended to the calculation of flow past a flight vehicle of complex configuration. The perturbed velocity potential on the surface of a rectangular wing is calculated as an example. AIAA

A93-33330
NUMERICAL CALCULATION OF POLARS AND HEAT TRANSFER IN SUPERSONIC THREE-DIMENSIONAL FLOW PAST WINGS WITH ALLOWANCE FOR RADIATION [CHISLENNYI RASCHET POLIAR I TEPLOOBMENA PRI SVERKHZVUKOVOM PROSTRANSTVENNOM OBTEKANII KRYL'EV S UCHETOM IZLUCHENIIA]
A. P. KOSYKH and G. A. SHCHEKIN *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 24-30. In Russian. refs
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The paper deals with the problem of determining the lifting characteristics and heat transfer in the case of supersonic three-dimensional flow past plane delta wings with a sharp leading

edge and an attached shock wave. The equilibrium surface temperature is determined with allowance for heat radiation on the basis of the Stefan-Boltzmann law. The three-dimensional nonviscous flow is calculated by solving a system of Euler nonlinear differential equations in Cartesian coordinates using a marching algorithm; the viscous flow is calculated by using a finite difference method to solve a system of partial differential equations. Flow calculations for the lower surface of a delta wing for Mach 6 and angles of attack of 5, 10, and 15 deg are presented as an example. AIAA

A93-33331
USING THE MARCHING METHOD AND GLOBAL ITERATIONS FOR CALCULATING THE THREE-DIMENSIONAL STEADY-STATE FLOWS OF GAS AND LIQUID ON THE BASIS OF PARABOLIZED NAVIER-STOKES EQUATIONS [O PRIMENENII MARSHEVOGO METODA I GLOBAL'NYKH ITERATSII DLIA RASCHETA TREKHMERNYKH STATSIONARNYKH TECHENII GAZA I ZHIDKOSTI NA OSNOVE PARABOLIZOVANNYKH URAVNENII NAV'E-STOKSA]
A. A. MARKOV *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 30-38. In Russian. refs
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The method proposed by Markov (1988) for calculating equations of a viscous shock layer is extended to three-dimensional flows of viscous gases and liquids with allowance for diffusion in the plane normal to the marching direction. Equations of a viscous shock layer, equations of a viscous layer, and parabolized Navier-Stokes equations are used to calculate supersonic flow of a viscous gas at an angle of sideslip past a blunt elliptical cone and a wing. Calculations are also made for a series of flows of a viscous liquid for plane and circular ducts. AIAA

A93-33333
CALCULATION OF SUBSONIC FLOW OF A GAS PAST AN AIRFOIL [RASCHET OBTEKANIIA PROFILIA DOZVUKOVYM POTOKOM GAZA]
V. D. SOFRONOV and R. V. KLIMENKO *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 42-47. In Russian. refs
Copyright

An iteration procedure for solving the problem of subsonic flow of a gas past an airfoil is presented. First, the problem of determining the flow velocity induced by the presence of the airfoil contour is solved in vorticity terms using the spline collocation method, with the source density assumed to equal zero. The normal velocity component due to the sources at the airfoil contour is then added to the right term of the equation for determining the vorticity, and the function of source distribution along the contour of the airfoil is calculated. AIAA

A93-33334
EFFECT OF THE WING PLANFORM ON THE OPTIMAL DEFORMATION OF THE MIDDLE SURFACE [VLIIANIE FORMY KRYLA V PLANE NA OPTIMAL'NUIU DEFORMATSIIU SREDINNOI POVERKHNOSTI]
M. I. NIKOLAEV *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 47-52. In Russian. refs
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A study is made of the effect of the wing planform and geometrical parameters (e.g., aspect ratio, taper, and leading-edge sweep angle) on the optimal deformation and twisting of the wing. Calculations are presented for wings of different geometries for Mach 0. It is shown that the planform, aspect ratio, taper, and sweep of the wing have no effect on the deformation mode of the middle surface, which is thought to be determined by the position of the section pressure center line over the wing span. AIAA

A93-33335
MINIMIZATION OF THE INDUCED DRAG OF NONPLANE LIFTING SYSTEMS [MINIMIZATSIIA INDUKTIVNOGO SOPROTIVLENIIA NEPLOSKIKH NESUSHCHIKH SISTEM]
A. N. KOLOBKOV and M. I. NIKOLAEV *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 52-57. In Russian. refs
Copyright

A numerical computation algorithm is proposed which makes it possible to determine the vorticity distribution in the wake of a lifting system that is optimal from the standpoint of minimum induced drag. The calculations based on the algorithm are found to be in good agreement with analytical results obtained for the Joined Wing system. A numerical implementation of the method for determining optimal vorticity in the wake of a lifting system makes it possible not only to determine the integral characteristics but also to solve the problem of determining the optimal form of the middle surface from a specified planform. AIAA

A93-33336
EFFECT OF FLEXURAL AND ROTATIONAL WING VIBRATIONS ON THE ELIMINATION OF FLOW SEPARATION [VLIIANIE IZGIBNYKH I VRASHCHATEL'NYKH KOLEBANII KRYLA NA LIKVIDATSIIU OTRYVA POTOKA]
A. IA. VASIL'EV *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 57-63. In Russian. refs
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An approximate method is proposed for calculating wing vibration regimes which will prevent flow separation. The method is based on the assumption that the suction produced during the downward motion of the wing trailing edge and eliminating flow separation is also sufficient for retaining nonseparated flow during the upward motion as a result of the inertia of the medium. It is demonstrated that such intermittent suction is capable of effectively preventing flow separation. Calculations are presented for the case of the rotational vibrations of the NACA 0012 airfoil. AIAA

A93-33337
PRESSURE FLUCTUATIONS ON A DELTA WING IN INCOMPRESSIBLE FLOW [O PUL'SATSIIAKH DAVLENIIA NA TREUGOL'NOM KRYLE V NESZHIMAEMOM POTOKE]
A. V. BAUMAN, A. L. LATYSHEV, and A. N. RADTSIG *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 63-68. In Russian. refs
Copyright

Results of an experimental study of pressure fluctuations at the trailing edge of a thin plane delta wing with a leading-edge sweep angle of 70 deg are presented. The tests were carried out in a subsonic wind tunnel, 2.25-m in diameter and 3.4 m long, at a free-stream velocity of 37 m/s and angles of attack of 0, 18, 26, and 34 deg. An analysis of the pressure fluctuation spectra at the trailing edge indicates that the spectrum depends on the angle of attack and the x coordinate. The spectrum also features a high-frequency fluctuation maximum below a stable and decayed vortex nucleus. AIAA

A93-33338
A STUDY OF THE EFFECT OF THE PARAWING SHAPE ON ITS LIFT-DRAG RATIO [ISSLEDOVANIE VLIIANIIA FORMY PARASHIUTA-KRYLA NA EGO AERODINAMICHESKOE KACHESTVO]
A. G. VIKTORCHIK, A. A. MIKHAILIUK, and A. S. PAVLOV *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 68-73. In Russian. refs
Copyright

The effect of the principal shape parameters of the parawing on its lift-drag ratio was investigated experimentally using rigid parawing models. The models were tested in a wind tunnel using a vertical moment instrument; the free-stream velocity was 20 m/s, corresponding to a Re number of 2 x 10 exp 5. The top cord attachment points, the leading edge curvature, and the canopy aspect ratio corresponding to the maximum lift-drag ratio are determined. AIAA

A93-33339
AN EXPERIMENTAL STUDY OF A COMPOSITE SUPERSONIC JET [EKSPERIMENTAL'NOE ISSLEDOVANIE SOSTAVNOI SVERKHZVUKOVOI STRUI]
E. N. BONDAREV, S. S. VTULKIN, E. I. MOSPANOV, and A. V. PECHERITSA *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 73-80. In Russian. refs
Copyright
Results of an experimental study of a free supersonic jet issuing from a twin nozzle are presented for different angles of attack and free-stream Mach numbers. It is shown that the collision of the individual jets leads to the formation of several shock waves. The singularities of the supersonic composite jet resulting from the interaction between the individual jets are identified. AIAA

A93-33341
THE VELOCITY POTENTIAL IN THE PROBLEM OF FLOW PAST THE TIP OF A RECTANGULAR WING WITH A THICKNESS DIMENSION [POTENTSIAL SKOROSTI V ZADACHE OBTEKANIIA KONTSA PRIAMOUGOL'NOGO KRYLA, IMEIUSHCHEGO TOLSHCHINU]
S. F. PETRISHIN TsAGI, Trudy no. 2504 1991 p. 3-21. In Russian. refs
Copyright
The problem of flow past the tip of a rectangular wing having a thickness dimension is analyzed in the context of linear theory. It is shown that a linear solution for a thin wing produced by the source method does not satisfy, with sufficient accuracy, the nonleakage condition on its surface. The principal error in this case is contributed by a solution in the neighborhood of the lateral edge of the wing, indicating that the linear solution is invalid in this region. A mathematical model of flow past the lateral edge of the wing is constructed which allows for the presence of a velocity potential discontinuity at the wing edge and formation of a surface of a tangential velocity discontinuity in this region. AIAA

A93-33342
SOME RESULTS OF PARAMETRIC STUDIES OF WINGS WITH END PLATES [NEKOTORYE REZUL'TATY PARAMETRICHESKIKH ISSLEDOVANII KRYL'EV S KONTSEVYMI SHAIBAMI]
N. A. CHICHEROV TsAGI, Trudy no. 2504 1991 p. 22-49. In Russian. refs
Copyright
Results of analytical and experimental studies of wings with end plates are reported. The results obtained make it possible to identify the regions of optimal parameters of the end plates and to determine their effect on the aerodynamic characteristics of the wing. The effects of different geometrical parameters of the wing and end plates are considered. AIAA

A93-33343
STUDIES OF THE EFFECTIVENESS OF MULTIELEMENT (FEATHERED) TIPS ON A STRAIGHT WING AT LOW VELOCITIES [ISSLEDOVANIIA EFFEKTIVNOSTI MNOGOELEMENTNYKH /'PER'EVYKH'/ ZAKONTSOVOK NA PRIAMOM KRYLE PRI MALYKH SKOROSTIAKH]
S. A. KRAVCHENKO and N. A. CHICHEROV TsAGI, Trudy no. 2504 1991 p. 50-58. In Russian. refs
Copyright
The effect of large-aspect-ratio multielement wing tips on the aerodynamic characteristics of a straight wing was investigated analytically and experimentally at low subsonic velocities. It is shown that the number of elements, their geometric parameters, and the mounting angle have a significant effect on the aerodynamic characteristics of the lifting system. For the multielement wing tips investigated, the increase in the lift-drag ratio was as high as 33 percent over the maximum value for the initial wing and 14 percent over that of a wing of the same span. AIAA

A93-33346
SELF-OSCILLATIONS DURING THE PARALLEL OUTFLOW OF TWO SUPERSONIC NONISOBARIC JETS [AVTOKOLEBANIIA PRI PARALLEL'NOM ISTECHENII DVUKH SVERKHZVUKOVYKH NEIZOBARICHESKIKH STRUI]
S. G. MIRONOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626) no. 5 Sept.-Oct. 1992 p. 29-36. In Russian. refs
Copyright
The generation of self-oscillations in a system of two parallel supersonic nonisobaric jets is examined with reference to new experimental results obtained by schlieren photography using a stroboscopic lamp synchronized by acoustic pressure pulses. Models are proposed which describe the directional characteristics of acoustic emission and the conditions of excitation of self-oscillations. The validity of the models is demonstrated experimentally. AIAA

A93-33349
CALCULATION OF A VISCOUS FLOW OF A VIBRATIONALLY NONEQUILIBRIUM MIXTURE OF GASES IN A HYPERSONIC NOZZLE [O RASCHETE VIAZKOGO TECHENIIA KOLEBATEL'NO-NERAVNOVESNOI SMESI GAZOV V GIPERZVUKOVOM SOPLE]
S. V. DOLGUSHEV and M. I. MUCHNAIA PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626) no. 5 Sept.-Oct. 1992 p. 51-56. In Russian. refs
Copyright
Flow of an N2-CO-Ar-He mixture in a two-dimensional nozzle of specified geometry is modeled using simplified Navier-Stokes equations. The analysis allows for vibrational-translational relaxation and intermolecular transfer of vibrational energy. The determination of the transfer properties of the mixture through consecutive transformations is ultimately reduced to the specification of the viscosity coefficients of the components. It is demonstrated that the simplified Navier-Stokes equations provide an adequate description of the flow. AIAA

N93-22395# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
AN APPROXIMATE METHOD FOR ESTIMATING THE LIFTING CHARACTERISTICS OF THIN BODIES OF NON-CIRCULAR CROSS-SECTION
P. A. T. CHRISTOPHER Jan. 1990 100 p
(CRANFIELD-AERO-9006; ISBN-1-871564-42-5; ETN-93-93551)
Avail: CASI HC A05/MF A02; Cranfield Inst. of Tech., Coll. Aeronautics, Cranfield, Bedford MK43 0AL, England, HC
A method based on that of Sacks for predicting the normal force distribution in thin bodies of noncircular cross section is developed. From this, the ratio, F(sub N), between the normal force gradient on the body of noncircular cross section and that of circular cross section, is calculated, the cross sectional area distribution, in the axial sense, being the same for both bodies. From a known, accurate, distribution on a body of revolution, the distribution on related families of bodies of noncircular cross section can be calculated, simply by multiplying by F(sub N)(x). The accurate distribution on the body of revolution may come from any convenient source including experiment. One way is to generate the lifting body by means of axial distributions of doublets. Both the indirect and direct aerodynamic problems are addressed and the technique is shown to offer a possible means for the design of lifting bodies. ESA

N93-22457*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
WING FLUTTER BOUNDARY PREDICTION USING AN UNSTEADY EULER AERODYNAMIC METHOD
ELIZABETH M. LEE-RAUSCH and JOHN T. BATINA Mar. 1993 13 p Proposed for presentation at the 34th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, La Jolla, CA, Apr. 1993
(Contract RTOP 505-63-50-12)
(NASA-TM-107732; NAS 1.15:107732) Avail: CASI HC A03/MF A01

Modifications to an existing three-dimensional, implicit, upwind Euler/Navier-Stokes code (CFL3D Version 2.1) for the aeroelastic analysis of wings are described. These modifications, which were previously added to CFL3D Version 1.0, include the incorporation of a deforming mesh algorithm and the addition of the structural equations of motion for their simultaneous time-integration with the government flow equations. The paper gives a brief description of these modifications and presents unsteady calculations which check the modifications to the code. Euler flutter results for an isolated 45 degree swept-back wing are compared with experimental data for seven freestream Mach numbers which define the flutter boundary over a range of Mach number from 0.499 to 1.14. These comparisons show good agreement in flutter characteristics for freestream Mach numbers below unity. For freestream Mach numbers above unity, the computed aeroelastic results predict a premature rise in the flutter boundary as compared with the experimental boundary. Steady and unsteady contours of surface Mach number and pressure are included to illustrate the basic flow characteristics of the time-marching flutter calculations and to aid in identifying possible causes for the premature rise in the computational flutter boundary. Author

N93-22487*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AUTOMATIC COMPUTATION OF WING-FUSELAGE INTERSECTION LINES AND FILLET INSERTS WITH FIXED-AREA CONSTRAINT
RAYMOND L. BARGER and MARY S. ADAMS Washington Mar. 1993 19 p
(Contract RTOP 505-59-53-01)
(NASA-TM-4406; L-17131; NAS 1.15:4406) Avail: CASI HC A03/MF A01

Procedures for automatic computation of wing-fuselage juncture geometry are described. These procedures begin with a geometry in wave-drag format. First, an intersection line is computed by extrapolating the wing to the fuselage. Then two types of filleting procedures are described, both of which utilize a combination of analytical and numerical techniques appropriate for automatic calculation. An analytical technique for estimating the added volume due to the fillet is derived, and an iterative procedure for revising the fuselage to compensate for this additional volume is given. Sample results are included in graphical form. Author

N93-22552*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPATIAL ADAPTATION PROCEDURES ON TETRAHEDRAL MESHES FOR UNSTEADY AERODYNAMIC FLOW CALCULATIONS
RUSS D. RAUSCH, JOHN T. BATINA, and HENRY T. Y. YANG Feb. 1993 15 p Presented at the AIAA 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993 Previously announced in IAA as A93-21116
(Contract RTOP 505-63-50-12)
(NASA-TM-107726; NAS 1.15:107726) Avail: CASI HC A03/MF A01

Spatial adaptation procedures for the accurate and efficient solution of steady and unsteady inviscid flow problems are described. The adaptation procedures were developed and implemented within a three-dimensional, unstructured-grid, upwind-type Euler code. These procedures involve mesh enrichment and mesh coarsening to either add points in high gradient regions of the flow or remove points where they are not needed, respectively, to produce solutions of high spatial accuracy at minimal computational cost. A detailed description of the enrichment and coarsening procedures are presented and comparisons with experimental data for an ONERA M6 wing and an exact solution for a shock-tube problem are presented to provide an assessment of the accuracy and efficiency of the capability. Steady and unsteady results, obtained using spatial adaptation procedures, are shown to be of high spatial accuracy, primarily in that discontinuities such as shock waves are captured very sharply. Author

N93-22654*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT INVESTIGATION OF THE EFFECT OF TAIL BOOM STRAKES ON HELICOPTER DIRECTIONAL CONTROL
HENRY L. KELLY, CYNTHIA A. CROWELL, KENNETH R. YENNI, and MICHAEL B. LANCE (Lockheed Engineering and Sciences Co., Hampton, VA.) Washington Feb. 1993 42 p
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-59-36-01)
(NASA-TP-3278; L-17068; NAS 1.60:3278; ATCOM-TR-93-A-003)
Avail: CASI HC A03/MF A01

A joint U.S. Army/NASA flight investigation was conducted utilizing a single-rotor helicopter to determine the effectiveness of horizontally mounted tail boom strakes on directional controllability and tail rotor power during low-speed, crosswind operating conditions. Three configurations were investigated: (1) baseline (strakes off), (2) single strake (strake at upper shoulder on port side of boom), and (3) double strake (upper strake plus a lower strake on same side of boom). The strakes were employed as a means to separate airflow over the tail boom and change fuselage yawing moments in a direction to improve the yaw control margin and reduce tail rotor power. Crosswind data were obtained in 5-knot increments of airspeed from 0 to 35 knots and in 30 deg increments of wind azimuth from 0 deg to 330 deg. At the most critical wind azimuth and airspeed in terms of tail rotor power, the strakes improved the pedal margin by 6 percent of total travel and reduced tail rotor power required by 17 percent. The increase in yaw control and reduction in tail rotor power offered by the strakes can expand the helicopter operating envelope in terms of gross weight and altitude capability. The strakes did not affect the flying qualities of the vehicle at airspeeds between 35 and 100 knots. Author

N93-22659# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Abt. fuer Numerische Stroemungsmechanik.
UPWIND RELAXATION METHOD FOR HYPERSONIC FLOW SIMULATION [UPWIND-RELAXATIONSMETHODE FUER DIE SIMULATION VON HYPERSCHALL-STROEMUNGEN]
BERNHARD MUELLER 25 Sep. 1991 85 p
(ISSN 0939-2963)
(DLR-FB-91-36; ETN-93-91925) Avail: CASI HC A05/MF A01; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

Upwind relaxation strategies were developed for space and time marching methods to solve the three dimensional Euler and thin layer Navier-Stokes equations for steady hypersonic flow of perfect gas over pointed and blunt bodies, respectively. The inviscid fluxes are discretized an upwind scheme, and the viscous fluxes are second order central differenced. For pointed bodies, the space marching method iterates the time dependent difference equations to the steady state in crossflow planes starting from a conical solution near the body apex. For blunt bodies, the time marching method employs an alternating planar Gauss-Seidel relaxation in the streamwise direction. Stability and convergence are enhanced by underrelaxing each wave in the crossflow planes individually. The methods are validated for inviscid and laminar hypersonic flows over a 10 deg circular cone and a sphere 15 deg cone. The present space marching method is about one order of magnitude more efficient than the time marching method. ESA

N93-22667 *Texas A&M Univ., College Station.*
AERODYNAMIC SENSITIVITY ANALYSIS IN THE TRANSONIC REGIME Ph.D. Thesis
HESHAM MAHMOUD EL-BANNA 1992 185 p
Avail: Univ. Microfilms Order No. DA9300429

The quasi-analytical approach is developed and applied to the three dimensional full potential equation to compute wing aerodynamic sensitivity coefficients in the transonic regime. Symbolic manipulation is used to reduce the effort associated with obtaining the sensitivity equations, and the large sensitivity system is solved using 'state of the art' routines. Various case studies are conducted and the results are compared to those obtained by the direct finite difference approach. Both methods are evaluated to determine their computational accuracy and efficiency. The quasi-analytical approach is shown to be accurate and efficient for large aerodynamic systems. Dissert. Abstr.

N93-22671*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STRUCTURAL DYNAMICS DIVISION RESEARCH AND TECHNOLOGY ACCOMPLISHMENTS FOR FY 1992 AND PLANS FOR FY 1993
ELEANOR C. WYNNE Washington Jan. 1993 218 p
(Contract RTOP 505-63-50-13)
(NASA-TM-107713; NAS 1.15:107713) Avail: CASI HC A10/MF A03

The purpose of this paper is to present the Structural Dynamics Division's research accomplishments for F.Y. 1992 and research plans for F.Y. 1993. The work under each Branch (technical area) is described in terms of highlights of accomplishments during the past year and highlights of plans for the current year as they relate to 5-year plans for each technical area. This information will be useful in program coordination with other government organizations and industry in areas of mutual interest. Author

N93-22802*# BSA Services, Houston, TX.
HYPERSONIC THREE-DIMENSIONAL NONEQUILIBRIUM BOUNDARY-LAYER EQUATIONS IN GENERALIZED CURVILINEAR COORDINATES
JONG-HUN LEE Feb. 1993 63 p
(Contract NAS9-18493)
(NASA-CR-185677; NAS 1.26:185677) Avail: CASI HC A04/MF A01

The basic governing equations for the second-order three-dimensional hypersonic thermal and chemical nonequilibrium boundary layer are derived by means of an order-of-magnitude analysis. A two-temperature concept is implemented into the system of boundary-layer equations by simplifying the rather complicated general three-temperature thermal gas model. The equations are written in a surface-oriented non-orthogonal curvilinear coordinate system, where two curvilinear coordinates are non-orthogonial and a third coordinate is normal to the surface. The equations are described with minimum use of tensor expressions arising from the coordinate transformation, to avoid unnecessary confusion for readers. The set of equations obtained will be suitable for the development of a three-dimensional nonequilibrium boundary-layer code. Such a code could be used to determine economically the aerodynamic/aerothermodynamic loads to the surfaces of hypersonic vehicles with general configurations. In addition, the basic equations for three-dimensional stagnation flow, of which solution is required as an initial value for space-marching integration of the boundary-layer equations, are given along with the boundary conditions, the boundary-layer parameters, and the inner-outer layer matching procedure. Expressions for the chemical reaction rates and the thermodynamic and transport properties in the thermal nonequilibrium environment are explicitly given. Author

N93-22822*# Akron Univ., OH.
NAVIER-STOKES ANALYSIS OF AIRFOILS WITH LEADING EDGE ICE ACCRETIONS Final Report
MARK G. POTAPCZUK Feb. 1993 206 p
(Contract NAG3-416; RTOP 505-68-10)
(NASA-CR-191008; E-7580; NAS 1.26:191008) Avail: CASI HC A10/MF A03

A numerical analysis of the flowfield characteristics and the performance degradation of an airfoil with leading edge ice accretions was performed. The important fluid dynamic processes were identified and calculated. Among these were the leading edge separation bubble at low angles of attack, complete separation on the low pressure surface resulting in premature shell, drag rise due to the ice shape, and the effects of angle of attack on the separated flow field. Comparisons to experimental results were conducted to confirm these calculations. A computer code which solves the Navier-Stokes equations in two dimensions, ARC2D, was used to perform the calculations. A Modified Mixing Length turbulence model was developed to produce grids for several ice shape and airfoil combinations. Results indicate that the ability to predict overall performance characteristics, such as lift and drag, at low angles of attack is excellent. Transition location is important for accurately determining separation bubble shape. Details of the flowfield in and downstream of the separated regions requires some modifications. Calculations for the stalled airfoil indicate periodic shedding of vorticity that was generated aft of the ice accretion. Time averaged pressure values produce results which compare favorably with experimental information. A turbulence model which accounts for the history effects in the flow may be justified. Author

N93-22823*# Illinois Univ., Urbana. Dept. of Aeronautical and Astronautical Engineering.
AN EXPERIMENTAL STUDY OF THE AERODYNAMICS OF A NACA0012 AIRFOIL WITH A SIMULATED GLAZE ICE ACCRETION, VOLUME 2 Final Report
MICHAEL B. BRAGG Cleveland, OH Mar. 1993 406 p
(Contract NAS3-28; RTOP 505-68-10)
(NASA-CR-191007; E-7690; NAS 1.26:191007) Avail: CASI HC A18/MF A04

This is the second volume of a report documenting the effect of simulated ice accretion on the aerodynamic performance of a NACA 0012 airfoil. Both an experimentally measured and a computer generated ice shape are studied. The purpose of this report is to present the results of the measurements, not an analysis of the data. Surface pressure, integrated lift and pitching moment data are presented as well as drag from a wake survey. A split hot film probe was used to document the flow-field about the airfoil with simulated ice. Data in the separation bubbles, reattached boundary layer and wake are presented. Both tabulated and graphical data are presented in the paper. The data are also available on computer disk for easy access. Author (revised)

N93-22876*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CHARACTERIZATION OF CAVITY FLOW FIELDS USING PRESSURE DATA OBTAINED IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL
M. B. TRACY and E. B. PLENTOVICH Washington Mar. 1993 35 p
(Contract RTOP 505-68-70-08)
(NASA-TM-4436; L-17158; NAS 1.15:4436) Avail: CASI HC A03/MF A01

Static and fluctuating pressure distributions were obtained along the floor of a rectangular-box cavity in an experiment performed in the LaRC 0.3-Meter Transonic Cryogenic Tunnel. The cavity studied was 11.25 in. long and 2.50 in. wide with a variable height to obtain length-to-height ratios of 4.4, 6.7, 12.67, and 20.0. The data presented herein were obtained for yaw angles of 0 deg and 15 deg over a Mach number range from 0.2 to 0.9 at a Reynolds number of 30 x 10(exp 6) per ft with a boundary-layer thickness of approximately 0.5 in. The results indicated that open and transitional-open cavity flow supports tone generation at subsonic and transonic speeds at Mach numbers of 0.6 and above. Further, pressure fluctuations associated with acoustic tone generation can be sustained when static pressure distributions indicate that transitional-closed and closed flow fields exist in the cavity. Cavities

that support tone generation at 0 deg yaw also supported tone generation at 15 deg yaw when the flow became transitional-closed. For the latter cases, a reduction in tone amplitude was observed. Both static and fluctuating pressure data must be considered when defining cavity flow fields, and the flow models need to be refined to accommodate steady and unsteady flows. Author (revised)

N93-23034*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ATTENUATION OF EMPENNAGE BUFFET RESPONSE THROUGH ACTIVE CONTROL OF DAMPING USING PIEZOELECTRIC MATERIAL
JENNIFER HEEG, JONATHAN M. MILLER (Cornell Univ., Ithaca, NY.), and ROBERT V. DOGGETT, JR. Feb. 1993 17 p Presented at Damping 1993, San Francisco, CA, 24-26 Feb. 1993 (Contract RTOP 590-14-61-01)
(NASA-TM-107736; NAS 1.15:107736) Avail: CASI HC A03/MF A01

Dynamic response and damping data obtained from buffet studies conducted in a low-speed wind tunnel by using a simple, rigid model attached to spring supports are presented. The two parallel leaf spring supports provided a means for the model to respond in a vertical translation mode, thus simulating response in an elastic first bending mode. Wake-induced buffeting flow was created by placing an airfoil upstream of the model of that the wake of the airfoil impinged on the model. Model response was sensed by a strain gage mounted on one of the springs. The output signal from the strain gage was fed back through a control law implemented on a desktop computer. The processed signals were used to 'actuate' a piezoelectric bending actuator bonded to the other spring in such a way as to add damping as the model responded. The results of this 'proof-of-concept' study show that the piezoelectric actuator was effective in attenuating the wake-induced buffet response over the range of parameters investigated. Author

N93-23108*# Pennsylvania State Univ., University Park. Dept. of Meteorology.
MIXED CONVECTIVE/DYNAMIC ROLL VORTICES AND THEIR EFFECTS ON INITIAL WIND AND TEMPERATURE PROFILES
TRACY HAACK (National Oceanic and Atmospheric Administration, Washington, DC.) and HAMPTON N. SHIRER Jul. 1991 114 p (Contract NAG8-780; NAS8-36150)
(NASA-CR-192349; NAS 1.26:192349) Avail: CASI HC A06/MF A02

The onset and development of both dynamically and convectively forced boundary layer rolls are studied with linear and nonlinear analyses of a truncated spectral model of shallow Boussinesq flow. Emphasis is given here on the energetics of the dominant roll modes, on the magnitudes of the roll-induced modifications of the initial basic state wind and temperature profiles, and on the sensitivity of the linear stability results to the use of modified profiles as basic states. It is demonstrated that the roll circulations can produce substantial changes to the cross-roll component of the initial wind profile and that significant changes in orientation angle estimates can result from use of a roll-modified profile in the stability analysis. These results demonstrate that roll contributions must be removed from observed background wind profiles before using them to investigate the mechanisms underlying actual secondary flows in the boundary layer. The model is developed quite generally to accept arbitrary basic state wind profiles as dynamic forcing. An Ekman profile is chosen here merely to provide a means for easy comparison with other theoretical boundary layer studies; the ultimate application of the model is to study observed boundary layer profiles. Results of the analytic stability analysis are validated by comparing them with results from a larger linear model. For an appropriate Ekman depth, a complete set of transition curves is given in forcing parameter space for roll modes driven both thermally and dynamically. Preferred orientation angles, horizontal wavelengths and propagation frequencies, as well as energetics and wind profile modifications, are all shown to agree rather well with results from studies on Ekman layers as well as with studies on near-neutral and convective atmospheric boundary layers. Author

N93-23203 Rice Univ., Houston, TX.
OPTIMIZATION OF FLIGHT TRAJECTORIES IN A 3D MODEL OF WINDSHEAR FLOW FIELD Ph.D. Thesis
HOO WANG 1992 109 p
Avail: Univ. Microfilms Order No. DA9234375

This thesis is concerned with the optimal flight trajectories in the presence of a three-dimensional windshear. Both the take-off and abort landing problems are studied. A mathematical model of a three-dimensional windshear is developed by the superposition of the flow fields of two symmetric vortex rings with appropriate parameters (circulation strength, radius, height). The flow field produced by this vortex ring pair is close to that of a real microburst. The wind components are functions of the geometric coordinates and can be obtained using either Biot-Savart law or the properties of the stream function. With this wind model, the strongest windshear and downdraft are located in a vertical plane passing through the central axis of the vortex ring pair. Therefore, in the computation of flight trajectories, the aircraft is assumed to fly in this vertical plane. Two cases are considered: (1) at the initial time, the aircraft is located in the region of strongest headwind; (2) at the initial time, the aircraft is located in the region of weak-to-moderate headwind. Case 1 implies late detection, while case 2 implies early detection of windshear. Optimal trajectories are computed for both take-off and abort landing. For the take-off problem, the performance index being minimized is the peak value of the deviation of the absolute path inclination from a reference value; for the abort landing problem, the performance index being minimized is the peak value of the altitude drop. The resulting optimal control problems are Chebyshev problems, which are converted into Bolza problems via suitable transformations. Then, the Bolza problems are solved by using the sequential gradient-restoration algorithm (SGRA). Numerical computations for both the take-off and abort landing problems lead to the following conclusions: (1) The survival capability of the optimal trajectory is superior to that of the constant pitch trajectory and the maximum angle of attack trajectory; this means that near-optimal guidance schemes should be developed to improve the survival capability of an aircraft in a severe windshear. (2) For the optimal trajectories, the survival capability in Case 2 (early detection) is superior to that in Case 1 (late detection); this indicates that early detection of a windshear can ehnace the safety of flight. Dissert. Abstr.

N93-23364# Aeritalia S.p.A., Pomigliano D'Arco (Italy). Gruppo Aerei da Trasporto.
A SYSTEM FOR THE NUMERICAL SIMULATION OF COMPLEX CONFIGURATION INTERNAL AERODYNAMIC FIELDS FOR THE AEROSPACE INDUSTRY [UN SISTEMA PER LA SIMULAZIONE NUMERICA DI CAMPI AERODINAMICA INTORNO A CONFIGURAZIONI COMPLESSE PER L'INDUSTRIA AEROSPAZIALE]
A. AMENDOLA and R. TOGNACCINI 1991 31 p In ITALIAN
(ETN-93-93698) Avail: CASI HC A03/MF A01

An outline for a system to simulate aerodynamic flow distribution for complex configurations is presented. The objectives of computational fluid dynamics in the aerospace industry are outlined. The computation method is based on Navier-Stokes and Euler equations of motion. A software for the analysis of complex aerodynamics configurations and future developments are shown. (The presentation is in the form of overhead projector graphics). ESA

N93-23392*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
NUMERICAL PREDICTION OF TRANSITION OF THE F-16 WING AT SUPERSONIC SPEEDS Final Report
RUSSELL M. CUMMINGS Mar. 1993 3 p
(Contract NCC2-754)
(NASA-CR-192706; NAS 1.26:192706) Avail: CASI HC A01/MF A01

This work is part of the high speed research program currently

underway at NASA. This project has the goal of gaining understanding of the technical requirements for supersonic-hypersonic flight. Specifically, this research is part of a continuing project to study the laminar flow over swept wings at high speeds and involves the numerical prediction of the flow about the F-16XL wing. The research uses the CNS/ARC3D codes and the resulting crossflow velocity components in order to estimate transition locations on the wing. Effects of angle of attack on the extent of laminar flows was found to be minimal. This result can be attributed to the fact that a laminar flow airfoil was used in this study, which has a continuous favorable pressure gradient over approximately the first 20 percent of the chord for angles of attacks up to 10 degrees. It should also be noted that even after 20 percent chord the pressure gradient either slowly continued to increase, but never decreased before 90 percent chord, except for the higher swept cases when separation occurs. Angles of attack greater than 10 degrees were not considered since this study assumes natural laminar flow for normal supersonic cruise flight conditions. Derived from text

N93-23399*# Illinois Univ., Urbana.
A STUDY OF THE ACCURACY OF NEUTRALLY BUOYANT BUBBLES USED AS FLOW TRACERS IN AIR
MICHAEL F. KERHO Cleveland, OH Mar. 1993 82 p Original contains color illustrations
(Contract NAG3-1134; RTOP 505-68-10)
(NASA-CR-191088; E-7630; NAS 1.26:191088) Avail: CASI HC A05/MF A01; 4 functional color pages

Research has been performed to determine the accuracy of neutrally buoyant and near neutrally buoyant bubbles used as flow tracers in air. Theoretical, computational, and experimental results are presented to evaluate the dynamics of bubble trajectories and factors affecting their ability to trace flow-field streamlines. The equation of motion for a single bubble was obtained and evaluated using a computational scheme to determine the factors which affect a bubble's trajectory. A two-dimensional experiment was also conducted to experimentally determine bubble trajectories in the stagnation region of NACA 0012 airfoil at 0 deg angle of attack using a commercially available helium bubble generation system. Physical properties of the experimental bubble trajectories were estimated using the computational scheme. These properties included the density ratio and diameter of the individual bubbles. the helium bubble system was then used to visualize and document the flow field about a 30 deg swept semispan wing with simulated glaze ice. Results were compared to Navier-Stokes calculations and surface oil flow visualization. The theoretical and computational analysis have shown that neutrally buoyant bubbles will trace even the most complex flow patterns. Experimental analysis revealed that the use of bubbles to trace flow patterns should be limited to qualitative measurements unless care is taken to ensure neutral buoyancy. This is due to the difficulty in the production of neutrally buoyant bubbles. Author (revised)

N93-23422*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN OVERVIEW OF AEROELASTICITY STUDIES FOR THE NATIONAL AEROSPACE PLANE
RODNEY H. RICKETTS, THOMAS E. NOLL, LAWRENCE J. HUTTSELL, and LAWRENCE J. HUTSELL Mar. 1993 13 p Presented at the AIAA 34th SDM Conference, 19-23 Apr. 1993
(Contract RTOP 763-23-41)
(NASA-TM-107728; NAS 1.15:107728) Avail: CASI HC A03/MF A01

The National Aero-Space Plane (NASP), or X-30, is a single-stage-to-orbit vehicle that is designed to takeoff and land on conventional runways. Research in aeroelasticity was conducted by NASA and the Wright Laboratory to support the design of a flight vehicle by the national contractor team. This research includes the development of new computational codes for predicting unsteady aerodynamic pressures. In addition, studies were conducted to determine the aerodynamic heating effects on vehicle aeroelasticity and to determine the effects of fuselage flexibility on the stability of the control systems. It also includes the testing of scale models to better understand the aeroelastic behavior of the X-30 and to obtain data for code validation and correlation. This paper presents an overview of the aeroelastic research which has been conducted to support the airframe design. Author (revised)

N93-23431*# Sverdrup Technology, Inc., Brook Park, OH.
UNSTEADY BLADE PRESSURES ON A PROPFAN: PREDICTED AND MEASURED COMPRESSIBILITY EFFECTS Final Report
M. NALLASAMY Jul. 1992 16 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE Original contains color illustrations
(Contract NAS3-25266; RTOP 535-03-10)
(NASA-CR-191087; E-7631; NAS 1.26:191087) Avail: CASI HC A03/MF A01; 2 functional color pages

The effect of compressibility on unsteady blade pressures is studied by solving the three-dimensional Euler equations. The operation of the eight-bladed SR7L propfan at a 4.75 deg angle of attack was considered. Euler solutions were obtained for three Mach numbers, 0.6, 0.7 and 0.8, and the predicted blade pressure waveforms were compared with flight data. The comparisons show that in general, the effect of Mach number on pressure waveforms are correctly predicted. The change in pressure waveforms are minimal when the Mach number is increased from 0.6 to 0.7. Increasing the Mach number from 0.7 to 0.8 produces significant changes in predicted pressure levels. The predicted amplitudes, however, differ from measurements at some transducer locations. At all the three Mach numbers, the measured (installed propfan) pressure waveforms show a relative phase lag compared to the computed (propfan along) waveforms due to installation effects. Measured waveforms in the blade tip region show nonlinear variations which are not captured by the present numerical procedure. Author (revised)

N93-23476# California Univ., Irvine. Combustion Lab.
TRANSVERSE INJECTION OF LIQUID AND GASEOUS FUELS INTO SUBSONIC/SUPERSONIC FLOW Final Report, Sep. 1988 - Dec. 1991
D. PAPAMOSCHOU, W. A. SIRIGNANO, and G. S. SAMUELSEN May 1992 81 p
(Contract F33615-88-C-2889)
(AD-A259771; UCI-ARTR-92-2; WL-TR-92-2046) Avail: CASI HC A05/MF A01

The goal of the program was to provide needed insight into the mixing behavior of liquid and gaseous jets injected transversely into a high velocity crossflow. The penetration of round supersonic jets normal to a supersonic cross flow was studied experimentally in a specially configured supersonic wind tunnel. The cross-flow stream consisted of air at Mach numbers of 2 and 3. The jet Mach number ranged from 1 to 3.53 and the jet gases employed were helium and argon. Schieren photography was the primary diagnostic. The effects of jet-to-freestream momentum ratio, jet and freestream Mach numbers, and pressure and density ratios at the jet exit were examined. It is found that penetration is strongly dependent on momentum ratio, weakly dependent on Mach numbers and pressure ratio, and independent of density ratio. For fixed momentum ratio, increasing freestream Mach number produced a small increase in penetration, while changing the jet Mach number produced no apparent effect. Values of pressure ratio that appear to maximize penetration are suggested. Flow visualization reveals large-scale turbulent structures in the jet and significant steadiness of the bow shock in front of the jet. GRA

N93-23489 Ohio State Univ., Columbus.
TIP-VORTEX/AIRFRAME INTERACTIONS Ph.D. Thesis
HABIB AFFES 1992 297 p
Avail: Univ. Microfilms Order No. DA9238117

The flow field generated by a helicopter in flight is extremely complex and it has been recognized that interactions between different components can significantly affect helicopter performance. In particular, the effects of the interaction between

the rotor wake, which consists of a highly three-dimensional helical vortex sheet and a high-strength tip-vortex, and the helicopter fuselage are extremely difficult to predict and pose a challenging problem for researchers and designers in the rotorcraft area. In the present work, the unsteady interaction of the rotor tip-vortex with the fuselage and the problem of the three-dimensional boundary-layer so generated on the fuselage underneath the vortex are investigated. In the first phase of the present work, a simplified model for the interaction of a rotor-tip-vortex with a fuselage or airframe is developed using three-dimensional potential flow analysis. The tip-vortex is idealized as a single three-dimensional vortex filament and the fuselage is modeled by an infinitely long circular cylinder. The Biot-Savart law is employed to describe the flow induced by the vortex and the flow is assumed to be inviscid and irrotational outside of the core of the vortex. The present analytical/numerical results for both the vortex trajectory and the pressure distribution on the airframe are in substantial agreement with experimental results prior to impact of the vortex with the airframe. The numerical calculations indicate that a large adverse pressure gradient develops under the vortex on the fuselage causing a rapid drop in the pressure there. The second phase of the present work focuses on the problem of the unsteady three-dimensional boundary-layer flow induced by the vortex filament moving above the fuselage. Three types of external flow in which the vortex is embedded are considered. These flows are respectively a stagnant medium, a symmetric mean flow and an asymmetric mean flow, the latter of which corresponds to the experimental conditions described above. In each case, the computed results show the development of a variety of complex three-dimensional boundary-layer separation phenomena. In all cases, the boundary-layer solutions show for formation of a secondary eddy which grows in time; this situation is expected to lead to an eruption of boundary-layer fluid into the free stream. The secondary eddy initially starts from a bubble-like shape of swirling flow and then evolves into a more complex structure; in particular, in the symmetric mean flow case, the secondary eddy evolves and grows in time and resembles the initiation of a horseshoe type vortex. Dissert. Abstr.

N93-23589 Washington State Univ., Pullman.
ACTIVE CONTROL OF THE SEPARATION REGION ON A TWO-DIMENSIONAL AIRFOIL Ph.D. Thesis
JULIE ANNE LOVATO 1992 148 p
Avail: Univ. Microfilms Order No. DA9238408

The effectiveness of combat aircraft depends in part on their ability to maintain high lift under extreme conditions. Examples of such conditions include the high angle of attack, rapid pitch motions necessary for combat maneuvers. A well known phenomenon occurring on airfoils undergoing such high angle of attack motions is the formation of a leading edge vortex. This vortex is preceded by significant increases in lift, but is also accompanied by subsequent rapid loss of lift and the ensuing dynamic stall. Prior to dynamic stall vortex formation, the unsteady separating boundary layer resembles the separating boundary layer over a static airfoil. Before developing control methodologies for unsteady flows, it is necessary to obtain a thorough understanding of the controlled flow over a static airfoil. This experimental analysis presents a comprehensive study of the separating boundary layer over a static airfoil under natural and actively controlled conditions. Near-surface hot-film and surface pressure measurements, as well as flow visualization are used to analyze the large-scale nature of the flow and determine forcing effects. Results from the static study are then extended for an initial evaluation of unsteady airfoil control. The fundamental frequency for a two-dimensional NACA-0015 airfoil is found to be an integral multiple of the frequency associated with wake structures. The static separating boundary layer response to active control confirms that it is a boundary layer transitioning to a free shear layer. Qualitative analyses show that significant reduction in overall static separation can be achieved under forcing conditions. Upper airfoil surface suction values are also significantly increased over the natural values. Applying tangential pulsed air control at static fundamental frequencies to a dynamic airfoil results in delay of the dynamic stall vortex formation and a delay of dynamic stall. These discoveries indicate that the developed control methodology may prove successful in increasing unsteady aircraft maneuverability. Dissert. Abstr.

N93-23594 Rensselaer Polytechnic Inst., Troy, NY.
ASYMPTOTIC ANALYSIS OF: 1: WAVE PROPAGATION IN DISPERSIVE OPTICAL MEDIA WITH QUADRATIC NONLINEARITY. 2: A HYPERSONIC WING WITH THREE-DIMENSIONAL SELF-SIMILARITY Ph.D. Thesis
ANDRE GABOR KALOCSAI 1992 134 p
Avail: Univ. Microfilms Order No. DA9236227

An asymptotic analysis is presented for two distinct and independent problems: (1) Wave propagation in dispersive optical media with quadratic nonlinearity; and (2) Hypersonic flows with three dimensional self-similarity. Asymptotic methods are useful for physical problems with small parameters in that the dominant physical process may be extracted from various parameter regimes that result in a simplified self-consistent mathematical analysis. The asymptotic method used depends critically upon the physical problem. In the optics problem, we at first study single and multiple input propagating waves at frequencies away from dielectric resonances. Here we compare the Slowly Varying Envelope Approximation to the Method of Multiple Scales and show that the Method of Multiple Scales is a superior technique that can be applied self consistently to any perturbation order which in turn predicts new physical effects. For the singly slowly modulated input wave problem, under appropriate conditions, we show that at the O(epsilon squared) perturbation, we obtain the cubic nonlinear Schrodinger equation. This means that for the single input wave propagating in a quadratic nonlinear medium, self-modulation effects and soliton behavior may be observed depending on the boundary conditions. For the problem with two input waves without phase matching, typical cross phase modulation equations are derived which are coupled cubic nonlinear Schrodinger equations. When two input waves have good phase matching, different asymptotic equations are obtained and illustrated such as the usual second harmonic generation problem which is a degenerate three wave mixing problem. For the single input wave near a classical dielectric resonance, we find that the wave number becomes amplitude dependent. The method of multiple scales is replaced by Whitham's averaged Lagrangian. We derive the associated modulated envelope equations. We investigate an effective medium regime and the full nonlinear problem. The hypersonic flow problem requires the use of asymptotic matching that arises from the geometry from the problem. Here the pressure field and lift to drag ratio C(sub L)(sup 3/2)/C(sub D) is evaluated for a wide delta wing with small power law curvature. Use is made of Hypersonic Small Disturbance Theory and three dimensional power law similarity. It is shown that an improvement for C(sub L)(sup 3/2)/C(sub D) occurs for wings with power law curvatures greater than one, when compared to flat delta wings. This improvement in performance agrees qualitatively with other types of concave wings. Dissert. Abstr.

N93-23714# Florida Agricultural and Mechanical Univ., Tallahassee. Fluid Mechanics Research Lab.
UNSTEADY FLOW PAST A PITCHING AIRFOIL AT MODERATELY HIGH SUBSONIC FREE STREAM MACH NUMBERS Final Report, 1 Jun. 1989 - 31 May 1992
A. KROTHAPALLI, G. BUZYNA, and L. LOURENCO 26 Oct. 1992 60 p
(Contract F49620-89-C-0067)
(AD-A260118; FMRL-TR-7; AFOSR-92-1011TR) Avail: CASI HC A04/MF A01

An experimental and computational investigation was carried out to study the flow past a NACA 0012 airfoil undergoing pitch up motion at free Mach numbers ranging 0.3 to 0.8. The flow velocity field was captured using PIV demonstrating the ability of the technique to characterize high speed separated flows. A companion computational study was conducted to assess the effect of wind tunnel walls on the dynamic stall process. GRA

N93-24058*# Continuum Dynamics, Inc., Princeton, NJ.
COMPUTATION OF ROTOR AERODYNAMIC LOADS IN FORWARD FLIGHT USING A FULL-SPAN FREE WAKE ANALYSIS
TODD R. QUACKENBUSH, DONALD B. BLISS, DANIEL A. WACHSPRESS, ALEXANDER H. BOSCHITSCH, and KIAT CHUA Oct. 1990 139 p
(Contract NAS2-13838; RTOP 505-59-36)
(NASA-CR-177611; A-91136; NAS 1.26:177611) Avail: CASI HC A07/MF A02

The development of an advanced computational analysis of unsteady aerodynamic loads on isolated helicopter rotors in forward flight is described. The primary technical focus of the development was the implementation of a freely distorting filamentary wake model composed of curved vortex elements laid out along contours of constant vortex sheet strength in the wake. This model captures the wake generated by the full span of each rotor blade and makes possible a unified treatment of the shed and trailed vorticity in the wake. This wake model was coupled to a modal analysis of the rotor blade dynamics and a vortex lattice treatment of the aerodynamic loads to produce a comprehensive model for rotor performance and air loads in forward flight dubbed RotorCRAFT (Computation of Rotor Aerodynamics in Forward Flight). The technical background on the major components of this analysis are discussed and the correlation of predictions of performance, trim, and unsteady air loads with experimental data from several representative rotor configurations is examined. The primary conclusions of this study are that the RotorCRAFT analysis correlates well with measured loads on a variety of configurations and that application of the full span free wake model is required to capture several important features of the vibratory loading on rotor blades in forward flight. Author

N93-24111*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SLOTTED-WALL FLOW-FIELD MEASUREMENTS IN A TRANSONIC WIND TUNNEL (Diskette Supplement)
JOEL L. EVERHART, WILLIAM B. IGOE, and STUART G. FLECHNER Washington Aug. 1991 110 p Diskette supplement: IBM compatible 3.5-inch diskette in ASCII format
(Contract RTOP 506-40-41-02)
(NASA-TM-4280; L-16865; NAS 1.15:4280;
NONP-SUPPL-DK-93-153709) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A13

Flowfield measurements obtained on the normal centerplane passing through a longitudinal slot in the wall of a transonic wind tunnel are presented. Data were acquired with a three-tube flow-angle probe, and distribution of flow angle, Mach number, and total pressure are given for free stream Mach numbers from 4.0 to 0.85. Cases are presented for tunnel empty and with a NACA 0012-64 airfoil model installed. Mass flow through the slot was varied by plenum suction over a range of 0 to 2 percent of the free-stream mass flow. The data are presented without analysis. The run schedule which details specific test conditions for each run is given in an appendix. A tabular listing of the data organized by run number is presented in a second appendix and is also provided on an IBM PC compatible 3.5-in. floppy disk in ASCII format. Author (revised)

N93-24118*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYTICAL AND EXPERIMENTAL STUDIES OF A SHORT COMPACT SUBSONIC DIFFUSER FOR A TWO-DIMENSIONAL SUPERSONIC INLET
CHANTHY IEK, RICHARD R. BURLEY, and ALBERT L. JOHNS Mar. 1993 65 p
(Contract RTOP 505-62-71)
(NASA-TP-3247; E-7111; NAS 1.60:3247) Avail: CASI HC A04/MF A01

An experimental study of a two-dimensional supersonic inlet with a short compact subsonic diffuser, length to exit diameter (dl/d) ratio of 1.25, was conducted to investigate the impact of the short diffuser on inlet performance at low speeds and to assess the diffuser subsonic performance for a simulated diffuser flow corresponding to high-speed inlet conditions near the design flight Mach number of 2.2. For the low-speed testing, a drooped lip was employed to improve the inlet performance at a high angle of attack. For the simulated high-speed testing, air was blown through slots or discrete nozzles as an active boundary-layer control. The results from the low-speed performance test were compared with the results from a previous test program on the same inlet with a long subsonic diffuser (dl/d = 4.5). The comparison indicates that inlet recovery was not affected by the use of the short diffuser for either the baseline (no droop) or the drooped cowl lip configuration. However, the inlet baseline distortion for the short diffuser configuration was substantially higher than for the long diffuser. A comparison of the two configurations with a 70 deg drooped lip showed no significant difference in distortion. For the portion of the experimental program in which diffuser conditions for high-speed flight were simulated, diffuser-induced flow separation occurred. This separation was predicted from an analytical study that used the Hess potential flow panel method and the Herring two-dimensional boundary-layer analysis computer codes. The flow separated mainly on the diffuser ramp. Subsequent tests in which boundary-control systems were utilized showed that blowing with either slots or discrete nozzles could suppress the flow separation in the short subsonic diffuser, thereby substantially improving the diffuser performance. Author (revised)

N93-24136 Old Dominion Univ., Norfolk, VA.
UNSTEADY EULER AND NAVIER-STOKES COMPUTATIONS AROUND OSCILLATING DELTA WING INCLUDING DYNAMICS Ph.D. Thesis
AHMED ABD-EL-BAR AHM SALMAN 1992 264 p
Avail: Univ. Microfilms Order No. DA9230211

Unsteady flows around rigid or flexible delta wings with and without oscillating leading-edge flaps are considered. These unsteady flow problems are categorized under two classes of problems. In the first class, the wing motion is prescribed a priori and in the second class, the wing motion is obtained as a part of the solution. The formulation of the first class includes either the unsteady Euler or unsteady Navier-Stokes equations for the fluid dynamics and the unsteady linearized Navier-displacement (ND) equations for the grid deformation. The problem of unsteady transonic flow past a bicircular-arc airfoil undergoing prescribed thickening-thinning oscillation is studied using the CFL2D code. This code is used to solve the Navier-Stokes equations using an implicit, flux-difference splitting, finite-volume scheme. For the unsteady supersonic flows around flexible delta wings with prescribed oscillating deformation and rigid delta wings with leading-edge-flap oscillations, the conservative, unsteady Euler and thin-layer Navier-Stokes equations in a moving frame-of-reference, along with the linearized ND equations, have been used. Two main problems are solved to demonstrate the validity of the developed schemes. The first problem is that of a flexible delta wing undergoing a prescribed bending-mode oscillation. In the second problem, a rigid-delta wing with symmetric and anti-symmetric flap oscillations is considered. These applications fall under the first class of problems. For the unsteady flow applications, where the wing motion is not prescribed a priori (second class of problems), either the unsteady Euler or thin-layer Navier-Stokes equations and the rigid-body dynamics equations, in a moving frame of reference, are solved sequentially to obtain the flow behavior and the wing motion. The main application for this class of unsteady flow phenomena, is the wing-rock problem. Using the locally-conical flow assumption, three problems are solved. The first is that of a delta wing undergoing a damped rolling oscillation. The second is that of a delta wing undergoing a limit-cycle, wing-rock motion. In the third problem, suppression of the wing-rock motion is demonstrated using a tuned anti-symmetric oscillation of the leading-edge flaps.
Dissert. Abstr.

N93-24209 Texas Univ., Austin.
AN EXPERIMENTAL STUDY OF THE DRIVING MECHANISM AND CONTROL OF THE UNSTEADY SHOCK-INDUCED TURBULENT SEPARATION IN A MACH 5 COMPRESSION CORNER FLOW Ph.D. Thesis
WILLIAM BERTON MCCLURE 1992 276 p
Avail: Univ. Microfilms Order No. DA9239313

This experimental study has examined the unsteady flowfield associated with the shock-induced separation of a turbulent boundary layer. The interaction was generated by a 28 deg unswept compression corner in a Mach 5 airstream. Perturbations were made to the interaction to better understand the mechanism responsible for the separation shock dynamics, as well as to demonstrate a method of controlling the shock motion. Local motion of the separation shock is associated with a characteristic signature in the wall pressure fluctuations beneath the incoming turbulent boundary layer. The shape of this signature is dependent only on whether the local shock motion is upstream or downstream. Fluctuating pitot pressure measurements made within the incoming boundary layer indicate that the maximum boundary layer interface crossing frequency is about five times that of the maximum separation shock zero crossing frequency. Power spectra from these pitot pressure data exhibit an increased role of low frequency (less than 2 kHz) fluctuations in the overall variance of the signal. This frequency range closely matches the dominant frequencies found in wall pressure fluctuations beneath the separation shock. Such fluctuations are not evident in the wall pressure or freestream pitot pressure measurements taken upstream of the interaction. Motion and location of the separated shear layer is found to be correlated with that of the separation shock such that the overall separation bubble exhibits a 'breathing' motion. As shown for the first time from the results of this study, the motion of the downstream limit of this bubble predominantly lags that of the upstream limit, independent of the direction of the bubble motion (inflating or collapsing). Motion of both the separation shock and shear layer seem to be secondary responses to primary, but undetermined, changes to the flowfield. Evidence of the shear layer motion is found at least as far downstream as 3.5 times the thickness of the incoming turbulent boundary layer. In all, these data suggest that the separation shock motion and associated flowfield unsteadiness is primarily driven by fluctuations in the outer two-thirds of the incoming turbulent boundary layer.
Dissert. Abstr.

N93-24215 Texas Univ., Austin.
THE EFFECT OF LARGE-SCALE UNSTEADY MOTION ON A TURBULENT REATTACHING SHEAR LAYER: APPLICATION TO THE SUPERSONIC COMPRESSION RAMP Ph.D. Thesis
MARTIN JOSEPH GUILLOT 1992 210 p
Avail: Univ. Microfilms Order No. DA9239262

A phenomenological model is developed to simulate the effect of large-scale unsteadiness which develops in a supersonic reattaching shear layer. The effect of the unsteadiness, predicted by the model, upon the mean flowfield in the reattachment region of a supersonic compression ramp, where flow separation and subsequent reattachment occurs, is then investigated. A triple decomposition is performed on the governing equations. The instantaneous values of velocity and pressure are decomposed into lower frequency, quasi-periodic fluctuations, higher frequency, random turbulent fluctuations, and mean components. The equations are 'short' time averaged over a time interval long enough to average the higher frequency fluctuations, but short enough so that the lower frequency fluctuations may be approximated as constant over the interval. The resulting equations are then separated into time-dependent and time-independent equations. However, since this study is primarily concerned with investigating the possible causes of the rapid acceleration of the inner region of the boundary layer downstream of reattachment, and it is believed that this is primarily due to the large-scale velocity and pressure fluctuations, lower frequency fluctuations of temperature are not considered. Furthermore, the so called Morkovin hypothesis is invoked for the small-scale, higher frequency random turbulence, so that density fluctuations are not considered. Therefore, the small scale turbulence is modeled with a zero-equation incompressible turbulence model. After time averaging, time-independent equations result which contain the usual Reynolds stresses, plus additional 'source' terms due to the large-scale unsteadiness. Additionally, a time-dependent momentum equation is obtained which describes the large-scale unsteadiness. The phenomenological model appears as a velocity boundary condition and a forcing function to this equation. An approximate form of the time-dependent equation is solved and analytical solutions are found that are used to calculate the 'source' terms in the time-independent equations. It is shown that by including the effect of the large-scale unsteadiness, improved predictions of experimental values are obtained. Furthermore, this provides a possible explanation for the rapid acceleration of the inner region of the boundary layer downstream of reattachment.
Dissert. Abstr.

N93-24224# United Technologies Research Center, East Hartford, CT.
AN OSCILLATING THREE-DIMENSIONAL WING EXPERIMENT: COMPRESSIBILITY, SWEEP, RATE, WAVEFORM, AND GEOMETRY EFFECTS ON UNSTEADY SEPARATION AND DYNAMIC STALL Final Report, Apr. 1989 - Nov. 1992
PETER F. LORBER, FRANKLIN O. CARTA, and ALFRED F. COVINO, JR. 30 Nov. 1992 187 p
(Contract DAAL03-89-C-0013)
(AD-A260530; UTRC/R92-958325-6; ARO-26631.8-EG) Avail: CASI HC A09/MF A02

Experimental measurements of the unsteady separation and dynamic stall process on an oscillating three-dimensional wing are reported. The experiment was conducted at Mach numbers of 0.2-0.6, Reynolds numbers of 2-6 million, and sweep angles of 0, 15, and 30 deg. At low Mach number, as angle of attack is increased the location of transition to turbulence moves forward, the turbulent boundary layer separates near the leading edge, and a strong stall vortex is formed. At higher Mach number, compressibility causes formation of a shock, an earlier, more gradual separation, and reduced unsteady loads. Unsteady tip loads at 0 sweep are increased by the growth of a strong tip vortex. This effect is lessened by sweep-back and compressibility, and enhanced by replacing the round tip cap with a flat tip. Away from the tip, sweep effects on loads are well represented by the swept infinite wing normalization until stall. After stall, vortex propagation patterns are highly dependent on sweep and spanwise position. Sinusoidal and constant pitch rate ramp motions show similar behavior. There is significant hysteresis in both the transition/relaminarization and the separation/reattachment processes. For small amplitude motions simulating stall flutter, substantial regions of negative aerodynamic damping were found -at all studied Mach numbers, sweep angles, and reduced frequencies. The near-simultaneous stall along the span of the swept wing strengthens the resulting instability. An empirical representation of the damping characteristics was developed.
GRA

N93-24263# Grumman Aerospace Corp., Bethpage, NY.
AN INVESTIGATION OF THE FUNDAMENTAL CAUSE OF ASYMMETRIC SEPARATED FLOW Final Report, 1 Apr. 1991 - 30 Jun. 1992
F. MARCONI Oct. 1992 49 p
(Contract DAAL03-91-C-0013)
(AD-A260296; ARO-28252.1-EG) Avail: CASI HC A03/MF A01

The cause of the phenomenon of steady asymmetric flow on cones at moderately high angles of attack is discussed. At very high angles of attack, the flow will become unsteady with a Karman vortex street being shed downstream. This second phenomenon was not considered. The investigation used computational fluid dynamics as a tool to uncover the fundamental cause of asymmetric separated flows. The appearance of new flow features as the critical angle of attack was approached was studied in detail. Isolating asymmetric disturbances to specific portions of the flow was also attempted. The stability of the symmetric flow above the critical angle of attack was investigated analytically. The transition of the flow from symmetric to asymmetric as the computation

was continued was studied in detail. All of these studies indicated that the interaction of the vortices in the cross flow plane results in an instability in the symmetric flow. In addition, the interaction between the vortices seems to be somewhat global in nature.
GRA

N93-24508# National Aerospace Lab., Tokyo (Japan).
LOW-SPEED WIND TUNNEL STUDY OF THE DIRECT LIFT AND DIRECT SIDE-FORCE CHARACTERISTICS OF A JOINED-WING AIRPLANE
T. FUJITA, A. IWASAKI, H. FUJIEDA, and N. TAKIZAWA Mar. 1992 29 p
(DE93-767971; NAL-TR-1142) Avail: CASI HC A03/MF A01

A diamond joined-wing airplane having wings with a sweepback angle and a dihedral angle linked with horizontal tails (rear wings) with a sweepforward angle and a cathedral angle can control lift and side force directly by operating combinedly the wing fins and the horizontal tail fins. If this control method can be used in an aircraft making a low-speed landing in a sudden gust or side-wind condition, the safety could be improved largely. This paper describes a low-speed wind tunnel test carried out on diamond joined-wing airplane models in four variations each having different area ratio between horizontal tails and wings. The experiment was conducted with the model plane fitted on three balance stanchions in the wind tunnel and subjected to a test wind velocity of 30 m/s. Investigations were given on the effect of the area of the fins and the horizontal tails on directly controlling the lift and side force. As a result, it was verified that the lift and side force can be controlled by operating properly each fin on the wings and the horizontal tails. DOE

N93-24524*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLOW MEASUREMENTS MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 8: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.23, 0.50 CHORD ABOVE THE TIP PATH PLANE (Diskette Supplement)
SUSAN L. ALTHOFF (Army Aviation Systems Command, Hampton, VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), DANNY R. HOAD (Army Aviation Systems Command, Hampton, VA.), and RICHARD H. SAILEY (Lockheed Engineering and Sciences Co., Hampton, VA.) May 1990 389 p Diskette supplement: 2 IBM compatible 5.25-inch DSDD diskettes Original contains color illustrations
(Contract RTOP 505-61-51-10)
(NASA-TM-102642; NAS 1.15:102642;
AVSCOM-TM-90-B-007-VOL-8; NONP-SUPPL-DK-93-159787)
Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A22; 2 functional color pages

An experimental investigation was conducted in the 14- by 22-Foot Supersonic Tunnel at the NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu = 0.23). The measurements were made with a two-component Laser Velocimeter (LV) 0.50 chord above the plane formed by the path of the rotor tips (tip-path-plane). A conditional sampling technique was employed to determine the position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 178 separate locations in order to clearly define the inflow character. The mean and standard deviation of the induced inflow ratios and the azimuthally dependent induced inflow ratios are included on 5.25 flexible disk in the pocket on the inside of the rear cover of this report. These data are presented without analysis. Author

N93-24525*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLOW MEASUREMENTS MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 9: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.23, 0.75 CHORD ABOVE THE TIP PATH PLANE (Diskette Supplement)
SUSAN L. ALTHOFF (Army Aviation Systems Command, Hampton, VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), DANNY R. HOAD (Army Aviation Systems Command, Hampton, VA.), and RICHARD H. SAILEY (Lockheed Engineering and Sciences Co., Hampton, VA.) May 1990 392 p Diskette supplement: 2 IBM compatible 5.25-inch DSDD diskettes Original contains color illustrations
(Contract RTOP 505-61-51-10)
(NASA-TM-102643; NAS 1.15:102643;
AVSCOM-TM-90-B-008-VOL-9; NONP-SUPPL-DK-93-159788)
Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A22; 2 functional color pages

An experimental investigation was conducted in the 14- by 22-Foot Subsonic Tunnel at the NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu = 0.23). The measurements were made with a two-component Laser Velocimeter (LV) 0.75 chord above the plane formed by the path of the rotor tips (tip-path-plane). A conditional sampling technique was employed to determine the position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 180 separate locations in order to clearly define the inflow character. The mean and standard deviation of the induced ratios and the azimuthally dependent induced inflow ratios are included on 5.25 flexible disk in the pocket on the inside of the rear cover of this report. These data are presented without analysis. Two floppy disks containing Inflow Measurements Volume 9 are included. Author

N93-24527*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLOW MEASUREMENTS MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 11: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.30, 0.75 CHORD ABOVE THE TIP PATH PLANE (Diskette Supplement)
SUSAN L. ALTHOFF (Army Aviation Systems Command, Hampton, VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), DANNY R. HOAD (Army Aviation Systems Command, Hampton, VA.), and RICHARD H. SAILEY (Lockheed Engineering and Sciences Co., Hampton, VA.) May 1990 392 p Prepared in cooperation with Army Aviation Systems Command, Hampton, VA Diskette supplement: 2 IBM compatible 5.25-inch DSDD Original contains color illustrations
(Contract RTOP 505-61-51-10)
(NASA-TM-102645; NAS 1.15:102645;
AVSCOM-TM-90-B-010-VOL-11; NONP-SUPPL-DK-93-159793)
Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A22; 2 functional color pages

An experimental investigation was conducted in the 14- by 22-Foot Supersonic Tunnel at the NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu = 0.30). The measurements were made with a two-component Laser Velocimeter (LV) 0.75 chord above the plane formed by the path of the rotor tips (tip-path-plane). A conditional sampling technique was employed to determine the position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 180 separate locations in order to clearly define the inflow character. The mean and standard deviation of the induced inflow ratios and the azimuthally dependent induced inflow ratio are included on 5.25 flexible disk in the pocket on the inside of the rear cover of this report. These data are presented without analysis. Author

N93-24528*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLOW MEASUREMENTS MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 10: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.30, 0.50 CHORD ABOVE THE TIP PATH PLANE (Diskette Supplement)
SUSAN L. ALTHOFF (Army Aviation Systems Command, Hampton,

VA.), JOE W. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), DANNY R. HOAD (Army Aviation Systems Command, Hampton, VA.), and RICHARD H. SAILEY (Lockheed Engineering and Sciences Co., Hampton, VA.) May 1990 386 p Diskette supplement: 2 IBM compatible 5.25-inch DSDD diskettes
(Contract RTOP 505-61-51-10)
(NASA-TM-102644; NAS 1.15:102644; AVSCOM-TM-90-B-009-VOL-10; NONP-SUPPL-DK-93-159794) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A22

An experimental investigation was conducted in the 14- by 22-Foot Subsonic Tunnel at the NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu = 0.30). The measurements were made with a two-component Laser Velocimeter (LV) 0.50 chord above the plane formed by the path of the rotor tips (tip-path-plane). A conditional sampling technique was employed to determine the position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 177 separate locations in order to clearly define the inflow character. The mean and standard deviation of the induced inflow ratios and the azimuthally dependent induced inflow ratios are included on 5.25 flexible disk in the pocket on the inside of the rear cover of this report. These data are presented without analysis. Author

N93-24532*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INDUCED INFLOW VELOCITY AND BLADE SURFACE PRESSURE MEASUREMENTS FOR A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 1: ADVANCE RATIO OF 0.37, THRUST COEFFICIENT OF 0.0081, AND HOVER TIP SPEED *OF 710 FT/SEC (Diskette Supplement)*
JOE E. ELLIOTT (Army Aviation Systems Command, Hampton, VA.), MARTIN A. PERYEA (Textron Bell Helicopter, Fort Worth, TX.), ALBERT G. BRAND (Textron Bell Helicopter, Fort Worth, TX.), and TOM L. WOOD (Textron Bell Helicopter, Fort Worth, TX.) Apr. 1992 468 p Prepared in cooperation with Army Aviation Systems Command, Hampton, VA Diskette supplement: IBM compatible 3.5-inch DSDD Original contains color illustrations
(Contract RTOP 505-59-36-01)
(NASA-TM-104224; NAS 1.15:104224; AVSCOM-TR-92-B-003-VOL-1; NONP-SUPPL-DK-93-159799) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A25; 2 functional color pages

An Advanced Lightweight Rotor (LAR) model was tested in high speed forward flight, mu = 0.37, at the 14- by 22-Foot Subsonic Tunnel at NASA LaRC. The pressure instrumented rotor, provided by Bell Helicopter, was a four-bladed, Mach-scaled, bearingless, soft-in-plane design. Rotor performance data was required from Bell's Powered Force Model (PFM) test stand, and the blade airfoils were obtained using 92 unsteady pressure transducers. A two-component laser velocimeter was used to obtain azimuthally dependent velocities in the inflow region and in the wake of the rotor. Data are presented here without analysis. To facilitate the use of the data sets, they are also provided on a 720 Kbyte 3 1/2-inch floppy disk in Microsoft Corporation MS-DOS format. The disk contains velocity time history data and blade pressure time history data. Author (revised)

N93-24538*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLOW MEASUREMENTS MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 7: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.40 (Diskette Supplement)
DANNY R. HOAD, SUSAN L. ALTHOFF, JOE W. ELLIOTT, and RICHARD H. SAILEY (Planning Research Corp., Hampton, VA.) Apr. 1989 388 p Diskette supplement: 2 IBM compatible 5.25-inch DSDD Original contains color illustrations
(Contract RTOP 505-61-51-10)
(NASA-TM-101599; NAS 1.15:101599; AVSCOM-TM-89-B-002; NONP-SUPPL-DK-93-159783) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A22; 2 functional color pages

An experimental investigation was conducted in the 14- by 22-Foot Subsonic Tunnel at the NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu = 0.40). The measurements were made with a two-component Laser Velocimeter (LV) one chord above the plane formed by the path of the rotor tips (tip-path-plane). A conditional sampling technique was used to determine the position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 178 separate locations in order to clearly define the inflow character. Two floppy disks are included that contain Inflow Measurements Volume 7--Rectangular Blades Advance Ratio = 0.40. Author

N93-24540*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLOW MEASUREMENTS MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 6: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.35 (Diskette Supplement)
DANNY R. HOAD, SUSAN L. ALTHOFF, JOE W. ELLIOTT, and RICHARD H. SAILEY (Planning Research Corp., Hampton, VA.) Apr. 1989 391 p Diskette supplement: 2 IBM compatible 5.25-inch DSDD
(Contract RTOP 505-61-51-10)
(NASA-TM-101598; NAS 1.15:101598; AVSCOM-TM-89-B-001; NONP-SUPPL-DK-93-159786) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A22

An experimental investigation was conducted in the 14- by 22-Foot Subsonic Tunnel at the NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu = 0.35). The measurements were made with a two-component Laser Velocimeter (LV) one chord above the plane formed by the path of the rotor tips (tip-path-plane). A conditional sampling technique was used to determine the position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 179 separate locations in order to clearly define the inflow character. Two floppy disks containing Inflow Measurements Volume 6--Rectangular Blades Advanced Ratio = 0.35 are included. Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A93-31929* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AERODYNAMIC EFFECTS OF DEICING AND ANTI-ICING FLUIDS
JOHN J. REINMANN (NASA, Lewis Research Center, Cleveland, OH) and DICK ADAMS Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 8, 9.

A special session in this issue of the Journal of Aircraft devoted to ground deicing and antiicing fluids is briefly reviewed. This section concentrates on the development of ground deicing and antiicing fluids and the measurement of their effects on takeoff aerodynamics. AIAA

A93-31931
DEVELOPMENT OF AN INTERNATIONAL STANDARD FOR SAFE WINTER OPERATION
R. HORNIG (Lufthansa German Airlines, Hamburg, Germany)

Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 14-18. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0758. Previously cited in issue 06, p. 805, Accession no. A91-19454 refs

A93-31932
AIRCRAFT GROUND DEICING, A FLIGHT CREW PERSPECTIVE
DAVID J. HAASE (Air Line Pilots Association, Herndon, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 19-23. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0761. Previously cited in issue 06, p. 805, Accession no. A91-19456 refs

A93-31935
NEW CONCEPT IN RUNBACK WATER MODELING FOR ANTI-ICED AIRCRAFT SURFACES
KAMEL M. AL-KHALIL (National Research Council, Washington), THEO G. KEITH, JR., and KENNETH J. DE WITT (Toledo Univ., OH) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 41-49. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0266. Previously cited in issue 06, p. 805, Accession no. A91-19210 Research sponsored by General Electric Co refs

A93-31962
LIGHTNING THREAT TO AIRCRAFT - DO WE KNOW ALL WE NEED TO KNOW?
VLADISLAV MAZUR (NOAA, National Severe Storms Lab., Norman, OK) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 156-159. Previously announced in STAR as N91-32600 refs
(Contract DTFA03-87-A-00021)

The problem of lightning threat to aircraft has two aspects: strike avoidance and aircraft protection. These two issues are addressed under the following topics: (1) lightning strikes, weather conditions, and natural lightning rate; (2) the engineering vs. scientific approach to aircraft protection; and (3) the additional information needed to understand lightning threat to aircraft.
Author

A93-32779
AN EVALUATION OF THE ROYAL AIR FORCE HELICOPTER SEARCH AND RESCUE SERVICES IN BRITAIN WITH REFERENCE TO ROYAL AIR FORCE VALLEY 1980-1989
W. J. LISKIEWICZ (RAF, Station Medical Centre, Ipswich, United Kingdom) Royal Society of Medicine, Journal (ISSN 0141-0768) vol. 85, no. 12 Dec. 1992 p. 727-729.

The Royal Air Force (RAF) operates a helicopter Search and Rescue (SAR) service in the United Kingdom and territorial waters; it also provides a similar service in several locations abroad. A 10-year retrospective study of the SAR helicopter service operating from the RAF base at Valley on the island of Anglesey in North Wales is presented, with national SAR statistics over a similar period provided for comparison. Analysis of records kept by SAR aircrew at RAF Valley shows that their assistance had been requested on 1490 occasions during the 10-year period studied; most of these requests were the result of incidents involving holidaymakers, particularly in the mountains or along the coast. The results illustrate the versatility and life-saving potential of a highly skilled and motivated service able to work in adverse weather and dangerous locations. In the light of current debate, the value of aeromedical evacuation of seriously ill patients using helicopters is discussed.
Author

N93-22379# Wichita State Univ., KS. National Inst. for Aviation Research.
THE ROLE OF UNIVERSITY RESEARCH IN AVIATION SAFETY AND COMPETITIVENESS: TESTIMONY TO THE US CONGRESS
WILLIAM H. WENTZ, JR. Feb. 1991 28 p
(NIAR-92-3) Avail: CASI HC A03/MF A01

Presented here are the written and oral testimony of the Executive Director of the National Institute for Aviation Research as it was given before the U.S. House of Representatives Committee on Science, Space, and Technology, Subcommittee on Technology and Competitiveness. Reasons for, and returns on, investment in university-based aviation research are discussed. Some specific activities at Wichita State University that were funded by the Federal Aviation Administration (FAA) include research on crashworthiness, stall-spin safety, electro-impulse-de-icing, the reliability of computer software used in aircraft, structural integrity, aging aircraft, human factors, advanced cockpits, propulsion and fuel systems, atmospheric hazards, flight safety, and other mostly safety-related aviation subjects. Wichita State University has conducted a number of workshops and seminars with the FAA, established a cooperative educational program with the FAA Technical Center, and participated in their Summer Faculty Research program. Barriers to innovation and competitiveness, and examples of successful research, development, and use of new information and technology are also given, as well as suggestions for improving aviation safety and competitiveness.
CASI

N93-22562*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
AN INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 1991-1992
ROBERT W. SIMPSON *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 3-7 Feb. 1993
Avail: CASI HC A01/MF A02

There are two completed projects and five new or continuing research activities under the sponsorship of the FAA/NASA Joint University Program as the 1991-92 period ends. A brief summary of some of the continuing research projects is provided. The active research projects are: (1) extensions for the FASA (Final Approach Spacing Advisory) System; (2) radar tracking around a turn; (3) impact of advanced technologies of single pilot IFR operations; (4) system and human limitations in millimeter wave and infrared synthetic vision systems; and (5) differences in party line information usage by operational user groups.
Derived from text

N93-22564*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
HAZARD EVALUATION AND OPERATIONAL COCKPIT DISPLAY OF GROUND-MEASURED WINDSHEAR DATA
CRAIG WANKE and R. JOHN HANSMAN, JR. *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 21-27 Feb. 1993 Presented at the AIAA 28th Aerospace Sciences Meeting, Reno, NV, 8-11 Jan. 1990 Previously announced in IAA as A90-19919 and A92-41216
(Contract NAG1-690; NGL-22-009-640)
(AIAA PAPER 90-0566) Avail: CASI HC A02/MF A02

Low-altitude windshear is the leading weather-related cause of fatal aviation accidents in the U.S. Since 1964, there have been 26 accidents attributed to windshear resulting in over 500 fatalities. Low-altitude windshear can take several forms, including macroscopic forms such as cold-warm gustfronts down to the small, intense downdrafts known as microbursts. Microbursts are particularly dangerous and difficult to detect due to their small size, short duration, and occurrence under both heavy precipitation and virtually dry conditions. For these reasons, the real-time detection of windshear hazards is a very active field of research. Also, the advent of digital ground-to-air datalinks and electronic flight instrumentation opens up many options for implementation

of windshear alerts in the terminal area environment. Study is required to determine the best content, format, timing, and cockpit presentation of windshear alerts in the modern ATC environment to best inform the flight crew without significantly increasing crew workload. Author

N93-22565*# Massachusetts Inst. of Tech., Cambridge.
HEAT TRANSFER ON ACCRETING ICE SURFACES
KEIKO YAMAGUCHI and R. JOHN HANSMAN, JR. *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 29-34 Feb. 1993
Presented at the AIAA 28th Aerospace Sciences Meeting, Reno, NV, 8-11 Jan. 1990 Previously announced in IAA as A90-22181 and A92-24415 Sponsored in part by NSF
(Contract NAG3-666; NGL-22-009-640)
(AIAA PAPER 90-0200) Avail: CASI HC A02/MF A02

Based on previous observations of glaze ice accretion on aircraft surfaces, a multizone model with distinct zones of different surface roughness is demonstrated. The use of surface roughness in the LEWICE ice accretion prediction code is examined. It was found that roughness is used in two ways: (1) to determine the laminar to turbulent boundary-layer transition location; and (2) to calculate the convective turbulent heat-transfer coefficient. A two-zone version of the multizone model is implemented in the LEWICE code, and compared with experimental convective heat-transfer coefficient and ice accretion results. The analysis of the boundary-layer transition, surface roughness, and viscous flowfield effects significantly increased the accuracy in predicting heat-transfer coefficients. The multizone model was found to significantly improve the ice accretion prediction for the cases compared. Author

N93-22566*# Massachusetts Inst. of Tech., Cambridge. Aeronautical Systems Lab.
HAZARD ALERTING AND SITUATIONAL AWARENESS IN ADVANCED AIR TRANSPORT COCKPITS
R. JOHN HANSMAN, CRAIG WANKE, JAMES KUCHAR, MARK MYKITYSHYN, EDWARD HAHN, and ALAN MIDKIFF *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 35-45 Feb. 1993
Previously announced in IAA as A93-14377
(Contract NAG2-12; NAG2-716; NAG1-690; NGL-22-009-640; DTRS-57-88-C-00078; NSF MSS-85-52702)
Avail: CASI HC A03/MF A02

Advances in avionics and display technology have significantly changed the cockpit environment in current 'glass cockpit' aircraft. Recent developments in display technology, on-board processing, data storage, and datalinked communications are likely to further alter the environment in second and third generation 'glass cockpit' aircraft. The interaction of advanced cockpit technology with human cognitive performance has been a major area of activity within the MIT Aeronautical Systems Laboratory. This paper presents an overview of the MIT Advanced Cockpit Simulation Facility. Several recent research projects are briefly reviewed and the most important results are summarized. Author

N93-22570*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT PRINCETON UNIVERSITY, 1991-1992
ROBERT F. STENGEL *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 91-100 Feb. 1993
Avail: CASI HC A02/MF A02

The Air Transportation Research Program at Princeton University proceeded along six avenues during the past year: (1) intelligent flight control; (2) computer-aided control system design; (3) neural networks for flight control; (4) stochastic robustness of flight control systems; (5) microburst hazards to aircraft; and (6) fundamental dynamics of atmospheric flight. This research has resulted in a number of publications, including archival papers and conference papers. An annotated bibliography of publications that appeared between June 1991 and June 1992 appears at the end of this report. The research that these papers describe was supported in whole or in part by the Joint University Program, including work that was completed prior to the reporting period. Author

N93-22574*# Princeton Univ., NJ.
OPTIMAL RECOVERY FROM MICROBURST WIND SHEAR
SANDEEP S. MULGUND *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 129-140 Feb. 1993
Avail: CASI HC A03/MF A02

Severe low-altitude wind variability represents an infrequent but significant hazard to aircraft taking off or landing. During the period from 1964 to 1985, microburst wind shear was a contributing factor in at least 26 civil aviation accidents involving nearly 500 fatalities and over 200 injuries. A microburst is a strong localized downdraft that strikes the ground, creating winds that diverge radially from the impact point. The physics of microbursts have only been recently understood in detail, and it has been found that effective recovery from inadvertent encounters may require piloting techniques that are counter-intuitive to flight crews. The goal of this work was to optimize the flight path of a twin-jet transport aircraft encountering a microburst during approach to landing. The objective was to execute an escape maneuver that maintained safe ground clearance and an adequate stall margin during the climb-out portion of the trajectory. Author

N93-22660# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Hauptabt. Verkehrsforschung.
OPTIONS OF AIR TRAFFIC DISTRIBUTION IN THE BERLIN REGION (GERMANY) [MOEGLICHKEITEN EINER AUFTEILUNG DES LUFTVERKEHRS AUF DIE FLUGHAEFEN DER REGION BERLIN]
DIETER WILKEN, STEFAN BEYHOFF, and VOLKER WARLITZER Oct. 1991 142 p In GERMAN
(Contract BMV-FE-L-7/90-50096/90) (ISSN 0939-2963)
(DLR-FB-91-37; ETN-93-91926) Avail: CASI HC A07/MF A02; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

Policy options for distributing air traffic between Berlin airports are studied. Such traffic distribution might be necessary as sufficient capacity will not be available in the foreseeable future to handle the growing air transport demand by a single Berlin airport. The study proceeds from a set of basic assumptions including the objectives in transport and environmental politics of the relevant political bodies, the air transport forecast for Berlin, and the development of airport capacities. Seven policy options are discussed and analyzed with a view to their application in the case of Berlin. The final policy advice calls for a market segmentation ruling with a continued application of IATA scheduling prodedures. ESA

N93-23004# Deutsche Lufthansa A.G., Cologne (Germany).
ACTIVITIES REPORT OF LUFTHANSA GERMAN AIRLINES Annual Report, 1991
ROLF-DIETER GRASS, ed. 1992 51 p
(ISSN 0722-3838)
(ETN-93-93465) Avail: CASI HC A04/MF A01

The Lufthansa German airlines annual report, which presents evidence of the negative effects of the world recession on the airline industry during 1991, is presented. It opens with a letter to the share holders and then reports to the executive board reviewing the international markets explaining the worldwide slowdown, increased turnover, how capacity exceeded demand, and how fees grew faster than costs. Passenger business, cargo business, financing, personnel, subsiduaries, the fleet, and services are reviewed. ESA

N93-23086# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: AIR TRANSPORT INTERNATIONAL, INC., FLIGHT 805, DOUGLAS DC-8-63, N794AL. LOSS OF CONTROL AND CRASH, SWANTON, OHIO, 15 FEBRUARY 1992
19 Nov. 1992 122 p
(PB92-910406; NTSB/AAR-92/05) Avail: CASI HC A06/MF A02

This report explains the loss of control and crash of Air Transport International, Inc., flight 805, a Douglas DC-8-63, near Toledo Express Airport, Ohio, after executing a second missed approach to runway 7, on 15 Feb. 1992. The safety issues discussed in the report include unusual attitude recovery training for flightcrews, crew fatigue, and cockpit resource management. Author (revised)

N93-23093 Virginia Polytechnic Inst. and State Univ., Blacksburg.
THE GENERATION OF CARBON MONOXIDE IN COMPARTMENT FIRES Ph.D. Thesis
DANIEL T. GOTTUK 1992 261 p
Avail: Univ. Microfilms Order No. DA9301010

For the purpose of fire analysis and fire safety engineering, the development of empirical correlations for major species yields in compartment fires has become an important priority due to the inability to calculate these quantities from first principles. Studies of simplified upper layer environments have shown that major species production rates can be correlated with the equivalence ratio in what is known as the Global Equivalence Ratio concept (GER). Due to the simplification in these past experiments, it was not known if the GER concept was valid for compartment fires. Therefore, there was a need to determine if correlations existed between major species yields and the equivalence ratio for actual compartment fires. Since the flow of toxic gases from a room poses a hazard to building occupants, it was also important to determine if correlations for CO yield outside of a compartment on fire exist, particularly when external burning occurs. A 2.2 cu m test compartment was used to investigate the burning of four fuels (hexane, PMMA, spruce and flexible polyurethane foam) in compartment fires. The test compartment was specially designed with a two-ventilation path system which allowed the direct measurement of the plume equivalence ratio (the ratio of the fuel volatilization rate to the air entrainment rate normalized by the stoichiometric fuel-to-air ratio). Empirical correlations between the upper layer yield of major species and the plume equivalence ratio were shown to exist. The results reveal the production of CO is primarily dependent on the compartment flow dynamics (i.e., the equivalence ratio) and upper layer temperature. A chemical kinetics study indicated that increased compartment temperature affects upper layer species yields in two ways: (1) the generation of species in the plume is changed and (2) oxidation of post-flame gases in the layer is affected. The correlations developed in the compartment fires were qualitatively similar to those developed by Beyler for simplified upper layer environments. However, quantitative differences existed and are explained by the temperature effect. The species yields downstream of hexane compartment fires were investigated and compared to upper layer yields. Results showed that downstream CO yields can be correlated to the plume equivalence ratio when taking into account the occurrence of external burning. When sustained external burning occurred for equivalence ratios greater than 1.7, downstream CO yields were reduced to 10 to 25 percent of the upper layer value. Results are very encouraging in indicating that an ignition criterion based on lean flammability limits is useful in predicting the flammability of upper layer gases in compartment fires. An ignition index value of 1.3 indicated the occurrence of sustained external burning and, thus, a reduction of CO, for the hexane fires studied. Dissert. Abstr.

N93-23187# National Transportation Safety Board, Washington, DC.
SAFETY STUDY: ALCOHOL AND OTHER DRUG INVOLVEMENT IN FATAL GENERAL AVIATION ACCIDENTS, 1983 THROUGH 1988
14 Oct. 1992 169 p
(PB92-917008; NTSB/SS-92/03) Avail: CASI HC A08/MF A02

The Safety Board conducted this study to examine alcohol and other drug involvement in fatal general aviation accidents that occurred from 1983 through 1988 and to compare the level of alcohol-involved accidents with the level documented in its 1984 statistical review of alcohol-involved aviation accidents that occurred from 1975 through 1981. For general aviation accidents that were fatal to the pilot-in-command, comparisons are made for two accident groups in terms of accident characteristics, flight conditions, pilot-in-command characteristics, and causes and factors. The alcohol-involved group consists of accidents in which alcohol was cited by the Safety Board as a cause or factor; the second group consists of accidents in which alcohol or other drugs were not cited as a cause or factor. Although the study briefly reviews accidents that were fatal to the pilot-in-command and in which drugs other than alcohol were cited as a cause or factor, the data are too limited for a comparative analysis to the alcohol-involved accidents or to accidents in which alcohol or other drugs were not cited. Derived from text

N93-23191# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: UNITED AIRLINES FLIGHT 585, BOEING 737-291, N999UA, UNCONTROLLED COLLISION WITH TERRAIN FOR UNDETERMINED REASONS, 4 MILES SOUTH OF COLORADO SPRINGS MUNICIPAL AIRPORT, COLORADO SPRINGS, COLORADO, 3 MARCH 1991
8 Dec. 1992 168 p
(PB92-910407; NTSB/AAR-92/06) Avail: CASI HC A08/MF A02

This report documents the inexplicable loss of United Airlines flight 585, a Boeing 737-291, after the airplane had completed its turn onto the final approach course to runway 35 at Colorado Springs Municipal Airport, Colorado Springs, Colorado, on 3 Mar. 1991. The safety issues discussed in the report are the potential meteorological hazards to airplanes in the area of Colorado Springs, potential airplane or systems anomalies that could have precipitated a loss of control, and the design of the main rudder power control unit servo valve that could present significant flight control difficulties under certain circumstances. Recommendations concerning these issues were addressed to the Federal Aviation Administration. Derived from text

N93-23222# National Inst. of Standards and Technology, Gaithersburg, MD.
MODELING THE HEAT RELEASE RATE OF AIRCRAFT CABIN PANELS Final Report
W. J. PARKER and R. FILIPCZAK (Federal Aviation Administration, Atlantic City, NJ.) Feb. 1993 52 p
(Contract DTFA03-87-A-0005)
(DOT/FAA/CT-92/3) Avail: CASI HC A04/MF A01

A computer model was developed to calculate the heat release rate of aircraft cabin composite panels based on the panel's thermophysical, chemical, and geometric properties. The model calculates the temperature through the panel as a function of time and uses this along with measured kinetic constants to deduce mass loss rate which is multiplied by the heat of combustion of the volatiles. The calculated results are in general agreement with the measured heat release obtained from the Ohio State University (OSU) calorimeter. Author

N93-23325# Oak Ridge National Lab., TN.
THE ANNUAL PROBABILITY OF AN AIRCRAFT CRASH ON THE US DEPARTMENT OF ENERGY RESERVATION IN OAK RIDGE, TENNESSEE
R. S. SEIGLER and L. J. LUTTRELL Nov. 1992 136 p
(Contract DE-AC05-84OR-21400)

(DE93-005171; ORNL/ENG/TM-36) Avail: CASI HC A07/MF A02

Aircraft hazards were evaluated to determine the total annual probability of an aircraft crash occurring at any structure located on the U.S. Department of Energy (DOE) reservation in Oak Ridge, Tennessee. This report documents the use of an accepted methodology for calculating the probability of an aircraft crash as applied to the three Oak Ridge plant sites including the adjoining facilities. Based on the data contained herein, the evaluation concluded that the probability of an aircraft crash occurrence at a single facility is generally considered 'not credible' as defined in DOE/OR-901. Additionally, reevaluation of probabilities would be necessary if significant changes were made to local air traffic. The probability of an aircraft crash could increase as a result of the opening of any new airport or heliport in the vicinity; a greater volume of air traffic from McGhee Tyson airport in Knoxville, should the airport status change from feeder airport to hub airport; the rerouting of commercial and/or military flights at the McGhee Tyson airport; and finally, a change in direction or the addition of a federal airway. At one time, DOE planned to establish a zone of prohibited airspace over the Y-12 plant; if the plans are enacted in the future, the probability of an aircraft crash at the Y-12 plant could decrease. Pilots since have been voluntarily requested not to fly below 3000 feet over the Y-12 plant. Also, the Federal Aviation Administration plans to reroute air traffic in the spring of 1993 on federal airway V16. However, the section of V16 which traverses the three plant sites and five adjoining facilities will not be altered. If this plan is implemented, the air traffic over the Oak Ridge facilities would not be affected significantly, and the probability of an aircraft crash as determined herein would be unchanged. DOE

N93-24200 Sundstrand Data Control, Inc., Redmond, WA.
GROUND PROXIMITY WARNING SYSTEM FOR USE WITH AIRCRAFT HAVING DEGRADED PERFORMANCE Patent
CHARLES D. BATEMAN, inventor (to Sundstrand Data Control, Inc.), JOHN H. GLOVER, inventor (to Sundstrand Data Control, Inc.), and HANS R. MULLER, inventor (to Sundstrand Data Control, Inc.) 11 Feb. 1992 24 p Filed 6 Apr. 1988
(CA-PATENT-1-295-716; INT-PATENT-CLASS-G01S-13/94; CTN-93-60640) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC

A ground proximity warning system for aircraft is provided which has enhanced warning capability when aircraft performance is degraded due to such factors as wind shear, improper landing configuration, insufficient engine thrust, instrument errors, and degraded lift. According to the invention, the warning envelope of Modes 1 and 3 are extended to within 5 ft. of the ground. Radio altitude rate and barometric altitude rate signals are combined to provide a computed altitude rate signal that is accurate near the ground for use as an input to Modes 1 and 3. The system provides flight path deviation warning utilizing a measure of flight path and aircraft altitude. A means for generating a warning when the aircraft pitch is below a predetermined value after rotation is also included, as well as an output indicating that additional aircraft performance is available. Angle of attack is compared to stall angle of attack to generate an indication that angle of attack should be increased. A pilot indication to apply additional thrust can also be provided. CISTI

N93-24592 Safety (Aircraft and Vehicles) Equipment Ltd. (England).
AIRCRAFT FIRE PROTECTION SYSTEM Patent
JAMES STEEL, inventor (to Safety Equipment Ltd.) 10 Mar. 1992 20 p Filed 17 Nov. 1987
(CA-PATENT-1-296-970; INT-PATENT-CLASS-A62C-35/58; CTN-93-60668) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC

A fire protection system is provided for an aircraft of the type having an onboard water supply system. The system comprises a plurality of spray nozzles dispersed throughout the passenger cabin, a plurality of distribution conduits interconnecting those nozzles, means for selectively connecting those conduits to the aircraft onboard water supply system, and means for optionally connecting those conduits to a source of pressurized water external to the aircraft. The external source connection means is positioned outside the aircraft so as to be accessible to fire fighting personnel outside the aircraft regardless of the aircraft's orientation. Preferably, the distribution conduits are configured to supply each of the plurality of spray nozzles along at least two alternate flow paths so that a redundancy is achieved. It is also preferred that the fire protection system includes means for limiting the flow of water in the distribution conduits in the event of a rupture of one of the conduits upstream of one or more of the plurality of spray nozzles. Author (CISTI)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A93-30252
INTEGRATION OF AVIATION DATA TRANSMISSION SYSTEMS [KOMPLEKSIROVANIE AVIATSIONNYKH SISTEM PEREDACHI INFORMATSII]
GEORGII A. KRYZHANOVSKII and MIKHAIL V. CHERNIAKOV Moscow Izdatel'stvo Transport 1992 296 p. In Russian. refs
(ISBN 5-277-00822-5) Copyright

The book is concerned with the possibility of increasing the level of flight safety through the integration of various kinds of air traffic control data. Methods for the optimal integrated processing of range, angle, and discrete data are presented, and the mathematical models used are described. Approaches to the integration of information and data display systems into automatic control systems, satellite systems, and collision prevention systems are reviewed. V.L.

A93-30424
DGPS PRECISION APPROACHES - AIRPORT-FRIENDLY
WARREN HUNDLEY and STEPHEN ROWSON (Wilcox Electric, Inc., Kansas City, MO) GPS World (ISSN 1048-5104) vol. 4, no. 3 March 1993 p. 28-34.
Copyright

Because of arrival-frequency congestion at airports, it may be impossible to install enough additional Category I Instrument Landing System (ILS) ground equipment to meet future demand for instrument approaches. Differential GPS (DGPS) is presently evaluated as a basis for a precision-approach system for commercial aircraft which can replace the Category I ILS. Attention is given to test results for the vertical and lateral accuracy of DGPS approaches. The best vertical results were achieved when a narrow-width correlator receiver was used with a fast differential data link. O.C.

A93-31348
GPS RAIM - SCREENING OUT BAD GEOMETRIES UNDER WORST-CASE BIAS CONDITIONS
GERALD Y. CHIN, JOHN H. KRAEMER (Volpe National Transportation Systems Center, Cambridge, MA), and R. G. BROWN (Iowa State Univ. of Science and Technology, Ames) Navigation (ISSN 0028-1522) vol. 39, no. 4 Winter 1992-1993 p. 407-427. Research sponsored by FAA refs
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A RAIM (Receiver Autonomous Integrity Monitoring) algorithm should provide a procedure for detection of a navigation failure, and a procedure for screening out geometries that may be satisfactory for navigation purposes, but cannot provide failure detection within the required specifications. This paper concentrates

on the screening function of RAIM. It compares the effectiveness of the older HDOP(max) criterion and a newer criterion called approximate radial-error protection (ARP). ARP is shown to be a much more reliable measure. The results of extensive Monte Carlo simulations are presented. In establishing reliable ARP ceilings for various phases of flight, it was found necessary to determine empirically the worst-case satellite bias that was applicable in each case. The main contribution is a reliable and straightforward screening criterion that can be readily implemented on line in a GPS receiver. Author

A93-31642
INTRODUCTION OF AN SSR SYSTEM INTO AIRPORT TRAFFIC CONTROL
KAKUICHI SHIOMI and TORAO ISHIBASHI (Electronic Navigation Research Inst., Mitaka, Japan) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 56-59. refs
Copyright

The simulation of a method for using SSR (Secondary Surveillance Radar) system as a sensor for identifying aircraft on the surface of an airport and for measuring their positions has been carried out. The results of this simulation show that more than 95 percent of aircraft were identified and their positions measured within the error of several tens of meters under the condition that three replies were garbled. In using this method the possibility of realizing a new airport surveillance system based on SSR is illustrated. Author (revised)

A93-31648
MANCHESTER AIRPORT AND SUB-CENTRE AIR TRAFFIC CONTROL SYSTEM
PETER R. WEST (Siemens Plessey Radar, Chessington, United Kingdom) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 88, 89.
Copyright

A novel air traffic control system provided for installation at Manchester International Airport is examined. The system features radar data processing, including tracking and code/callsign conversion, and display facilities necessary for the provision of air traffic control services at the airport and subcenter. The system employs an open system architecture, with a two-tier computer architecture connected by a dual local area network. Display processing facilities, short-term conflict alert facilities, and radar recording are also discussed. AIAA

A93-31651
THE PRINCIPLE AND TECHNIQUE OF DOPPLER BEAM SHARPENING (DBS)
ZHIZHONG ZHANG (Nanjing Research Inst. of Electronic Technology, China) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 98-102. refs
Copyright

The principles of DBS and its related formulas are derived. Two different sharpening methods suitable for small and large sharpening ratio is discussed, their advantages and disadvantages are pointed out with numerical examples. Finally, a fixed angle DBS flying test is given. Author

A93-31653
SYSTEM DESIGN AND HARDWARE IMPLEMENTATION OF A RADAR FOR SURFACE DETECTION AT AIRPORTS
R. K. ARORA, M. C. KUMAR, and S. SETHI (Department of Electronics, New Delhi, India) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 111-114. Research supported by Department of Electronics of India refs
Copyright

An optimized system design of a Radar for Surface Detection at Airports is presented. The hardware implementation of the design shows that it provides a cost-effective solution. It is based on a proven technology X-band marine radar transreceiver suitably modified for airport surface detection application and equipped with certain distinctive features not found in the similar radars. A specially designed large slotted waveguide antenna and a software driven high resolution raster scan color data display have been used in the system. The configuration is flexible to accommodate varying requirements of the airports. Author

A93-31704
FOCUSING OF HIGH RESOLUTION IMAGING RADARS AND RELATED PROBLEMS
P. FINCATO, G. PICARDI, R. SEU, and C. ZELLI (Roma I, Univ., Rome, Italy) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 343-346. Research supported by CNR and Alenia Spazio S.p.A refs
Copyright

A technique for estimating flight parameters based on an analysis of the scene focused with low-range resolution of about 10 m in range and 1.5 m in azimuth is proposed. An uncertainty in the velocity of 5 percent and on a squint angle of 20 mrad entail an uncertainty over the RCM for the central point of the scene within 7 m in the worst conditions (height = 5000 m, off-nadir angle = 60 deg, and squint angle = 45 deg). Thus a low resolution of 10 m in ground range will be sufficient to compensate for the range cell migration of the central point of the scene and of the whole scene in the first step. A homogeneous scene in the center of which there are eight point scatterers forming a square, before and after the final step of the proposed focusing algorithm, is shown. AIAA

A93-31709
ON THE IMPLEMENTATION OF THE OPTIMUM SPATIAL-TEMPORAL PROCESSOR FOR AIRBORNE SURVEILLANCE SYSTEMS
HONG WANG and LUJING CAI (Syracuse Univ., NY) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 365-368. refs
(Contract F30602-89-C-0082)
Copyright

Implementing the optimum spatial-temporal (angle-Doppler) processor involves two crucial issues: the selection of processing configurations, and the development of adaptive algorithms which can efficiently approach the performance potential of the selected configuration. Among the three available configurations, the joint-domain, the cascade spacetime, and the cascade time-space, this paper shows that, in contrast to a popular belief, the detection performance potentials of both cascade configurations can fall far below that of the joint-domain optimum. In addition, this paper presents a new adaptive algorithm, called the Joint-Domain Localized Generalized Likelihood Ratio detection (JDL-GLR), which is data-efficient (i.e., with fast convergence to the joint-domain optimum), as well as computationally efficient, together with such desirable features as the embedded CFAR and robustness in non-Gaussian clutter/interference. Author

A93-31721
AN ADAPTIVE-LENGTH CA-CFAR DEVICE FOR AN ATC RADAR
M. BASILE, A. DI VITO, C. FALESSI, and L. PASQUALI (Alenia S.p.A., Rome, Italy) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 419-422. refs
Copyright

The main problems affecting the behavior of a Cell Averaging Constant False Alarm Rate (CA-CFAR) device are the presence of disturbance discontinuities in the reference window due to clutter banks and the presence of interfering targets. As a consequence,

false alarm probability is not constant and sensitivity losses increase. The proposed device tries to overcome the above mentioned effect through the detection of disturbance discontinuities; this determines the number and the position of the reference samples used to calculate the value of the adaptive threshold. As the device works in an ATC environment, possible interfering targets are likely to fall within the reference window; therefore, the elimination of echoes relevant to more interfering targets is accomplished. A series of Monte Carlo simulations have been carried out to evaluate the performances of the device. The results show good performances in terms of CFAR characteristics and sensitivity losses. Author (revised)

A93-31728
A RESEARCH INTO DBS SYSTEM OF AIRBORNE FORWARD LOOKING RADAR
JIANHANG YANG and BO JIANG (Air Force College of Engineering, Xian, China) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 451-454. refs
Copyright

A method of replacing traditional FFT by modern spectrum estimation to realize a Doppler filter of a DBS system is proposed in order to improve azimuth resolution and radar image formation quality. Some reasonable selection principles for system parameters are suggested, and some strict quantitative expressions which are indispensable to the determination of system parameters are derived. The computer simulation experiment proves the practicability and advanced performance of the DBS system with the modern spectrum analysis technique to realize Doppler filtering. AIAA

A93-32141
THE CONTINUITY OF SERVICING AND THE OPERATIONAL READINESS COEFFICIENT OF AIR-NAVIGATION RADIO-ELECTRONIC SYSTEMS [NEPRERYVNOST' OBSLUZHIVANIIA I KOEFFITSIENT OPERATIVNOI GOTOVNOSTI AERONAVIGATSIONNYKH RADIOELEKTRONNYKH SISTEM]
V. A. IVANOV Radiotekhnika (ISSN 0033-8486) no. 10-11 Oct.-Nov. 1992 p. 7-10. In Russian. refs
Copyright

Markov models for the maintenance process are used to obtain formulas for estimating the continuity of servicing of air-navigation radio-electronic systems. Results are presented for the maintenance of an SP-80 landing system. AIAA

A93-32143
COMPLEX PROCESSING OF INFORMATION IN TWO-COORDINATE RADIO DIRECTION FINDERS [KOMPLEKSNAIA OBRABOTKA INFORMATSII V DVUKHKOORDINATNYKH RADIOPELENGATORAKH]
A. V. OCHNEV Radiotekhnika (ISSN 0033-8486) no. 10-11 Oct.-Nov. 1992 p. 41-48. In Russian. refs
Copyright

A device for the complex processing of signals in an onboard two-coordinate radio direction finder with a two-dimensional antenna array is synthesized on the basis of Markov-theory methods using the principle of information separation. The device is suitable for the complex spatial-temporal processing of signals on the background of external and internal noise in a direction finder with a 2D antenna array. AIAA

A93-32509
HEIGHT ACCURACY AND SYNTHETIC APERTURE RADAR IMAGE LAYOVER
M. DESAI (MIT, Lexington, MA) *In* Synthetic aperture radar; Proceedings of the Meeting, Los Angeles, CA, Jan. 20, 21, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 2-14. Research supported by DARPA refs
(Contract F19628-90-C-0002)
Copyright

A problem of computing height information from a pair of radar images is considered focusing on the tradeoff between the accuracy of height estimate and limited angular persistence of radar scatterers. When elevated scatterers appear closer in range, i.e., when radar image layover occurs, the height of a scatterer can be computed from the difference in its layover between two images. It is shown that the difference in layover is zero for any image pair taken from a constant altitude straight-line flight path and, therefore, images are spatially coherent. Accuracy of a height estimate is calculated as a function of range resolution and the angular difference between slant planes. As the angle between the slant planes increases the accuracy of the slant estimate improves, but bright scatterers in one image tend to fade in the other image. AIAA

A93-32511
MODIFIED SPOTLIGHT MODE FOR A MMW SYNTHETIC APERTURE RADAR
WILLIAM A. HOLM (Georgia Inst. of Technology, Atlanta) *In* Synthetic aperture radar; Proceedings of the Meeting, Los Angeles, CA, Jan. 20, 21, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 28-34. refs
Copyright

A modified SAR mode capable of reducing the signal processing load that is often required to correct for range walk and range ambiguity effects is presented. In this mode the antenna is kept fixed as the real beam transverses the desired portion of the ground to be imaged (the 'spot') and is then back-scanned in azimuth to put the beam on the leading edge of the spot and again allowed to transverse the spot. This procedure is repeated until the desired aspect-angle coverage is obtained. The modified spotlight mode imposes no restrictions on spot size to avoid range-walk and high pulse repetition frequency (PRF) problems. It is noted that the modified spotlight mode requires a longer time to image the entire spot than the conventional mode and does not provide continuous aspect-angle imaging. AIAA

A93-32512
THE LINCOLN LABORATORY MILLIMETER-WAVE SYNTHETIC APERTURE RADAR (SAR) IMAGING SYSTEM
J. C. HENRY, T. J. MURPHY, and K. M. CARUSONE (MIT, Lexington, MA) *In* Synthetic aperture radar; Proceedings of the Meeting, Los Angeles, CA, Jan. 20, 21, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 35-52. Research sponsored by DARPA refs
(Contract F19628-90-C-0002)
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The Lincoln Laboratory SAR imaging system based on an airborne radar that operates at 33.56 GHz is described. Raw radar data are recorded on high-density digital tapes which are processed at the Radar Data Analysis Center to create calibrated SAR and RAR images. This ground processing facility includes an image formation processor, an archival storage and retrieval system, and a cluster of computer systems. The calibration process consists of the three major steps: (1) an internally-generated calibration pulse is inserted into the radar receiver at the front end, (2) calibration targets deployed on the ground are measured by the radar from air, and (3) polarimetric calibration is performed using the measurements from the first two steps. AIAA

A93-32520
PRODUCTION AND USE OF SYNTHETIC APERTURE IMAGES OF AIRCRAFT - ADAPTIVE BEAMFORMING AND 3-D STEREO VIEWING
BERNARD D. STEINBERG and DONALD L. CARLSON (Pennsylvania Univ., Philadelphia) *In* Synthetic aperture radar; Proceedings of the Meeting, Los Angeles, CA, Jan. 20, 21, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 131-140. Research supported by USAF and U.S. Army refs
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The formation of 2D high resolution ISAR images of targets such as aircraft and other vehicles without a priori knowledge of target trajectory, as well as SAR imaging without electromechanical platform stabilization, are discussed. Two data-adaptive self-calibration algorithms that perform beamforming and focusing are described. The radio camera is the self-calibrating phased-array instrument used. X-band, 150 MHz bandwidth images are presented. SAR detection sensitivity is considerably enhanced when stereo pairs of such images are presented to the operator. Experiments are described using radar data of a commercial airplane for the target, and fields of farmland for the clutter background. The images of each stereo pair differ only in the horizontal locations of the targets relative to the clutter. The increase in detection sensitivity varied between 20 and 40 dB. The anticipated gain under nonlaboratory conditions is the order of 20 dB. Author (revised)

N93-22390# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Cockpitsysteme und Ergonomie.
TERRAIN REFERENCED INFORMATION AND GUIDANCE SYSTEMS (TRIGS)
DIETER HOFFMANN and ALEXANDER RUMPF Sep. 1991 10 p In GERMAN Presented at DGLR e.V. Forschungsintitut fuer Anthropotechnik der FGAN e.V. 34th Fachausschusssitzung, Munich, Germany, 24-25 Sep. 1991
(MBB-FE-315-S-PUB-0494; ETN-93-93436) Avail: CASI HC A02/MF A01

The Cooperative Air Traffic Management Concept (CATMAC) is considered, in the framework of the German organization for flight safety. The improvement of the coordination between onboard/ground and aircraft/flight safety is outlined. The technical prerequisites are given. Terrain Referenced Information and Guidance Systems (TRIGS) is shown to contribute as an aircraft oriented landing area guiding system to the required increase of the system capacity. General aspects are considered, such as the reduction of workload in the cockpit, the safety increase in air and on the ground, the reduction of delays, and collision avoidance. ESA

N93-22398# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
SOLUTION TO A MULTICRITERIA AIRCRAFT ROUTING PROBLEM UTILIZING PARALLEL SEARCH TECHNIQUES M.S. Thesis
JAMES J. GRIMM, II Dec. 1992 248 p
(AD-A259293; AFIT/GCE/ENG/92D-04) Avail: CASI HC A11/MF A03

Pilots select routes based on factors such as threats, fuel, time on target, distance, and refueling points. This is a time consuming task. This thesis presents the software engineering synthesis of a software tool, based on a parallelized A* search algorithm, to select routes. For simplicity only threats and distance are used. A centralized open list is used with one processor managing the list while the other processors perform the node expansions. This decomposition result in a dynamically load balanced system. A number of parameters are changed to study their impact on the execution time. The use of a branch and bound technique and its impact on the execution time is studied. Other parameters examined are the size of the supercomputer and granularity of the algorithm. It is important to match the software granularity to the architecture to ensure maximum utilization of the supercomputer and minimize execution time. Tests were run on both an iPSC/2 and iPSC/860 to determine the effects of the architecture upon the execution time. In conjunction with execution time, the efficient usage of the parallel computer was also examined. GRA

N93-22563*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
THE ASLOTS CONCEPT: AN INTERACTIVE, ADAPTIVE DECISION SUPPORT CONCEPT FOR FINAL APPROACH SPACING OF AIRCRAFT (FASA). FAA-NASA JOINT UNIVERSITY PROGRAM
ROBERT W. SIMPSON *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 9-20 Feb. 1993
Avail: CASI HC A03/MF A02

This presentation outlines a concept for an adaptive, interactive decision support system to assist controllers at a busy airport in achieving efficient use of multiple runways. The concept is being implemented as a computer code called FASA (Final Approach Spacing for Aircraft), and will be tested and demonstrated in ATCSIM, a high fidelity simulation of terminal area airspace and airport surface operations. Objectives are: (1) to provide automated cues to assist controllers in the sequencing and spacing of landing and takeoff aircraft; (2) to provide the controller with a limited ability to modify the sequence and spacings between aircraft, and to insert takeoffs and missed approach aircraft in the landing flows; (3) to increase spacing accuracy using more complex and precise separation criteria while reducing controller workload; and (4) achieve higher operational takeoff and landing rates on multiple runways in poor visibility. Author

N93-22568*# Ohio Univ., Athens.
FAULT DETECTION AND ISOLATION
GREG BERNATH *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 67-76 Feb. 1993
Avail: CASI HC A02/MF A02

Erroneous measurements in multisensor navigation systems must be detected and isolated. A recursive estimator can find fast growing errors; a least squares batch estimator can find slow growing errors. This process is called fault detection. A protection radius can be calculated as a function of time for a given location. This protection radius can be used to guarantee the integrity of the navigation data. Fault isolation can be accomplished using either a snapshot method or by examining the history of the fault detection statistics. Author

N93-22569*# Ohio Univ., Athens.
GPS MULTIPATH ERRORS IN THE PRECISION LANDING ENVIRONMENT
JAMES D. WAID *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 77-88 Feb. 1993
(Contract NAG1-1423; NGR-36-009-017)
Avail: CASI HC A03/MF A02

Aircraft guidance and positioning during the final approach and landing phases of flight requires a high degree of accuracy. The Global Positioning System operating in differential mode (DGPS) is being considered for this application. Prior to implementation, all sources of error must be considered. Multipath has been shown to be the dominant source of error for DGPS. Theoretical studies have verified the severity of multipath within the final approach and landing regions. This paper presents a study of GPS multipath errors during these critical phases of flight. A discussion of GPS multipath error characteristics will be presented along with actual multipath data. The data was collected using P-code and C/A-code receiver architectures. Data was collected onboard a dual-engine fixed-wing research aircraft. Aircraft dynamics are considered in the data analysis. Author

N93-22571*# Princeton Univ., NJ.
ADVANCED AIR TRAFFIC MANAGEMENT
J. P. WANGERMANN *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 101-106 Feb. 1993
Avail: CASI HC A02/MF A02

Air traffic worldwide continues to grow, and this growth is predicted to continue in the coming decades. Air traffic management (ATM) systems in several parts of the world have now reached their operating limits. The external symptoms of this are increases in the number of delays experienced by the system, and a rise in the frequency of near-misses. If the ATM system fails to develop to provide more capacity, then the result will be a

decrease in safety levels, and increasing delays, or a limit on the number of permitted aircraft operations. Author

N93-22572*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
COMPUTER AIDED CONTROL SYSTEM DESIGN (CACSD)
FRANK T. STONER *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 107-113 Feb. 1993
Avail: CASI HC A02/MF A02

The design of modern aerospace systems relies on the efficient utilization of computational resources and the availability of computational tools to provide accurate system modeling. This research focuses on the development of a computer aided control system design application which provides a full range of stability analysis and control design capabilities for aerospace vehicles. Author

N93-22573*# Princeton Univ., NJ.
SYNTHESIS OF ROBUST CONTROLLERS
CHRIS MARRISON *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 115-127 Feb. 1993
Avail: CASI HC A03/MF A02

At the 1990 American Controls Conference a benchmark problem was issued as a challenge for designing robust compensators. Many compensators were presented in response to the problem. In previous work Stochastic Robustness Analysis (SRA) was used to compare these compensators. In this work SRA metrics are used as guides to synthesize robust compensators, using the benchmark problem as an example. Author

N93-22787# Societe d'Applications Generales d'Electricite et de Mecanique, Paris (France).
OPTIMIZATION OF THE INTEGRATION OF INERTIA AND GPS [INTEGRATION OPTIMISEE DE L'INERTIE ET DU GPS]
M. LOIEC CAMBERLEIN, BERNADETTE CAPIT, and M. PASCAL DEBANNE *In* AGARD, Integrated and Multi-Function Navigation 9 p Nov. 1992 In FRENCH
Copyright Avail: CASI HC A02/MF A02

ULISS NG is an Inertia-GPS unit and an interesting example of INS/GPS synergy and performance/cost trade-off. It belongs to the ULISS family of INS already fitted to a number of different aircraft. Its miniaturized code twelve channel embedded receiver, with its RF and digital modules, totals 0.7, 1, 7 kg and 12 W. Its parallel tracking maximizes navigation continuity, smoothness, accuracy and minimizes reaction time and oscillator size. The tight Inertia-GPS coupling, i.e., tight inertial aiding and tight hybrid navigation Kalman filter, has been designed to favor operational capabilities, performance and solution stability. Four versions of the SAGEM embedded GPS receiver have been developed C/A-SPS, C/A-SA-PPS and P(Y)L1 and P(Y)L1/L2. The P code version is presented in the paper. Flight tests are being conducted in a Mirage 3 at the French Official Flight Test Center of Bretigny starting in May. Author

N93-22788# GEC Ferranti, Edinburgh (Scotland). Navigation Systems Div.
RETROFITTING OF GPS INTO EXISTING NAVIGATION SUITES
D. I. CALLENDER and N. F. WATSON *In* AGARD, Integrated and Multi-Function Navigation 18 p Nov. 1992
Copyright Avail: CASI HC A03/MF A02

As GPS signal availability reaches operationally useful levels, and in particular following experience of its usefulness in the Gulf operations, widespread requirements are beginning to arise for the incorporation of GPS into existing combat aircraft. A considerable amount of study and development work has been carried out by GEC Ferranti to investigate different approaches to integrating GPS into existing navigation systems with the minimum impact on installation, interfacing and operating procedures. This paper describes some different approaches to integrating GPS together with their relative merits and deficiencies. Two practical systems are described in detail and some simulation and trials results are presented together with some aspects of the GPS integration which will form the basis of future development work. Author

N93-22789# Technische Univ., Brunswick (Germany). Inst. of Flight Guidance and Control.
INTEGRATED PRECISION NAVIGATION SYSTEM
G. SCHAENZER and B. TIEMEYER *In* AGARD, Integrated and Multi-Function Navigation 10 p Nov. 1992
Copyright Avail: CASI HC A02/MF A02

Combined Satellite and Inertial Navigation Systems can achieve extremely high positioning accuracies in the sub meter range even in the dynamic environment of aircraft. This paper presents the concept of the 'Integrated Navigation System' developed at the Institute of Flight Guidance using coupled satellite and inertial sensors. Flight test results are shown, which demonstrate that this system has the potential to achieve the accuracy requirements according to ICAO CAT 3 for high precision approaches even under bad weather conditions. Author

N93-22790*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLIGHT EVALUATION OF DIFFERENTIAL GPS AIDED INERTIAL NAVIGATION SYSTEMS
B. DAVID MCNALLY, RUSSELL A. PAIELLI, RALPH E. BACH, JR., and DAVID N. WARNER, JR. *In* AGARD, Integrated and Multi-Function Navigation 17 p Nov. 1992
Copyright Avail: CASI HC A03/MF A02

Algorithms are described for integration of Differential Global Positioning System (DGPS) data with Inertial Navigation System (INS) data to provide an integrated DGPS/INS navigation system. The objective is to establish the benefits that can be achieved through various levels of integration of DGPS with INS for precision navigation. An eight state Kalman filter integration was implemented in real-time on a twin turbo-prop transport aircraft to evaluate system performance during terminal approach and landing operations. A fully integrated DGPS/INS system is also presented which models accelerometer and rate-gyro measurement errors plus position, velocity, and attitude errors. The fully integrated system was implemented off-line using range-domain (seventeen-state) and position domain (fifteen-state) Kalman filters. Both filter integration approaches were evaluated using data collected during the flight test. Flight-test data consisted of measurements from a 5 channel Precision Code GPS receiver, a strap-down Inertial Navigation Unit (INU), and GPS satellite differential range corrections from a ground reference station. The aircraft was laser tracked to determine its true position. Results indicate that there is no significant improvement in positioning accuracy with the higher levels of DGPS/INS integration. All three systems provided high-frequency (e.g., 20 Hz) estimates of position and velocity. The fully integrated system provided estimates of inertial sensor errors which may be used to improve INS navigation accuracy should GPS become unavailable, and improved estimates of acceleration, attitude, and body rates which can be used for guidance and control. Precision Code DGPS/INS positioning accuracy (root-mean-square) was 1.0 m cross-track and 3.0 m vertical. (This AGARDograph was sponsored by the Guidance and Control Panel.) Author

N93-22791# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany). Dept. of Aerospace Technology.
VISUAL AUTONOMOUS AUTOMATIC LANDING OF AIRPLANES
E. D. DICKMANNS and F.-R. SCHELL *In* AGARD, Integrated and Multi-Function Navigation 9 p Nov. 1992
Copyright Avail: CASI HC A02/MF A02

A visual sensor data processing method has been developed and validated which allows to achieve on board autonomous landing approaches in the visual flight regime with computing technology available today; sensors are a video-camera, inertial gyros and an air velocity meter. The key feature of the method is the reconstruction and servo-maintained adjustment by prediction error

feedback of an internal spatio-temporal model about the process to be controlled (4D approach). This encompasses both the ego motion state of the aircraft carrying the sensors and the relevant geometric properties of the runway and its spatial environment. The efficiency of the approach is proved both in a hardware-in-the-loop simulation and in real test-flights with a twinturbo-prop aircraft Do 128 of Dornier. For accuracy evaluation of the data gathered, the results of differential GPS and radio metric altitude measurements have been recorded simultaneously. Author

N93-22792# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. of Flight Guidance.

SCENE CORRELATION FOR INS AIDING IN FLIGHT-TEST SYSTEMS: RUNWAY-REFERENCED FLIGHT-TESTS WITH ON-BOARD SENSORS ONLY

B. STIELER and H.-U. DOEHLER *In* AGARD, Integrated and Multi-Function Navigation 15 p Nov. 1992

Copyright Avail: CASI HC A03/MF A02

Inertial and image-derived measurements for runway referenced flight path computations are investigated. They open the way for flight-tests without ground-based sensors and with a minimum of a priori knowledge or none at all about the runway position and direction in absolute coordinates. They are ideally suited for inspecting landing aids at congested civil airports, for instance. The investigations concentrate on the problems of the baroinertial and inertial altitude measurements, on the achievable accuracies of image-derived measurements and their integration with inertial measurements. It is shown that glide path and flight track accuracies in the order of 0.01 deg (1 sigma) should be achievable. Author

N93-22793# Defence Research Establishment, Ottawa (Ontario). Communication and Navigation Section.

AN HIERARCHIC ALLIANCE OF FILTERS FOR FAULT TOLERANT NAVIGATION USING TWO INERTIAL SYSTEMS WITH AIDING SENSORS

J. CHRIS MCMILLAN, JEFF S. BIRD, and DALE A. G. ARDEN (Computers and Concepts Associates, Ontario.) *In* AGARD, Integrated and Multi-Function Navigation 11 p Nov. 1992

Copyright Avail: CASI HC A03/MF A02

A Dual Inertial Integrated Navigation System (DIINS) is being developed for the Canadian Navy to improve the navigational accuracy and reliability on ships which have two inertial navigators plus other aiding navigation systems and sensors such as GPS, Loran-C, Omega, Doppler Speed Log(s) and so on. The sensor integration architecture being proposed to optimally combine all navigation sensors on such a vessel is an 'hierarchic alliance' of Kalman filters, which is designed to allow sensitive error compensation as well as complete fault detection isolation and reconfiguration (FDIR). This architecture is ideally suited to central processing, can take advantage of parallel processing, and provides significant advantages over both the conventional unifilter approach and the 'federated' (or cascaded) filter approach. This hierarchic alliance consists of a specific set of optimal filters running in parallel, with each filter processing measurements from a different subset of the navigation sensors. These filters can be partially ordered so that primary and secondary filters can be defined. The primary filter(s) provide the optimal navigation solution, while the secondary filters provide uncorrupted backup in the event of a sensor fault. The primary motivating factor for this architecture is to provide optimal integration under all conditions, and in particular after the occurrence of subtle sensor faults which could not be immediately detected and which could therefore corrupt the primary filter(s). This alliance of filters can provide an uncorrupted optimal solution, since it can be configured so that there will always be a secondary filter which, at the time of failure, was running independently of the faulty sensor. This removes the usual need to 'back out' of a failure which was not immediately detected and thus substantially simplifies reconfiguration in response to such a failure. Another motivating factor for this architecture is that the partial independence of the parallel filters also facilitates the detection and isolation of sensor faults. This can be accomplished by multiple levels of statistical hypothesis testing on a set of parallel Kalman filters. Fault detection techniques used include the usual sensor data reasonableness and filter residual tests as well as a chi-square hypothesis testing technique applied to the state vectors, and inter-filter voting applied to the residuals test results. While this approach is computationally intensive, modern software techniques, and soon to be available processing power, are expected to make the real time implementation of this hierarchic alliance of filters quite practical. The system envisioned in this paper is being designed and built at the Defence Research Establishment Ottawa for the Canadian Navy and is expected to see initial real-time sea trials in 1993. Author

N93-22794*# Ohio Univ., Athens. Avionics Engineering Center.

TOWARD ACHIEVING GLOBAL SOLE MEANS RADIONAVIGATION SYSTEMS

F. VANGRAAS *In* AGARD, Integrated and Multi-Function Navigation 10 p Nov. 1992

(Contract NGR-009-017; DTRS-57-87-C-00006)

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This paper briefly reviews tentative requirements for global, earth-referenced sole means of navigation systems with emphasis on integrity and availability. These requirements can be allocated to integrated navigation system architectures based on for instance GPS, GLONASS, VOR/DME, TACAN, Omega, Chayka, and Loran-C. Fault detection and isolation techniques (FDI) for integrated radio navigation systems are presented. The FDI algorithm provides a protection radius with a specified confidence level as a function of measurement geometry and algorithm requirements. This is followed by a case study of integrated GPS/Loran-C. Author

N93-22801# Federal Aviation Administration, Atlantic City, NJ. Technical Center.

AIR TRAFFIC OPERATIONAL EVALUATION PLAN OF THE AUTOMATED SURFACE OBSERVING SYSTEM (ASOS) DISPLAYS

WILLIAM BRENNER, CHRIS MALITSKY, ALANNA RANDAZZO, and BRUCE E. WARE Mar. 1993 36 p

(DOT/FAA/CT-TN92/36) Avail: CASI HC A03/MF A01

The Automated Surface Observing System (ASOS) is a weather collection and display system that will be installed in airport traffic control towers (ATCT). The system is being procured, installed, operated, and maintained by the National Weather Service (NWS) for the Federal Aviation Administration (FAA). The FAA's evaluation of the limited production ASOS system, which is being produced by SMI Corporation, is outlined. The FAA will conduct the evaluation of the limited production ASOS at seven air traffic field sites. Four of the named sites will be commissioned and the controller will be expected to use only that weather information generated by the ASOS and have the capability of inputting tower observed visibility when it falls below 4 miles. The remaining three sites will be noncommissioned sites where the controllers will undergo training and then evaluate the ASOS as they familiarize themselves with the system. Two of the three sites are also Limited Aviation Weather Reporting Station (LAWRS) which will permit the controller to augment the weather. Data will be collected via questionnaires completed by the air traffic control specialists (ATCS) at the seven sites and analyzed by FAA Technical Center personnel. The results of the evaluation will be used for consideration in making changes to the ASOS system prior to full production. Author (revised)

N93-23063# Federal Aviation Administration, Atlantic City, NJ.

STRUCTURE AND UTILITY OF BLIND SPEED INTERVALS ASSOCIATED WITH DOPPLER MEASUREMENTS OF RANGE RATE

ROBERT G. MULHOLLAND Feb. 1993 62 p

(DOT/FAA/CT-TN92/27) Avail: CASI HC A04/MF A01

In the case of a coherent pulsed radar system, the time rate of change of the slant range of an aircraft may be determined to within an integer multiple of a known speed by measuring the pulse-to-pulse phase shift in the reflection of a transmitted wave

train of electromagnetic energy. The integer multiplier is not necessarily a known, and lack of knowledge of the multiplier gives rise to an ambiguity. The ambiguity may be removed by appropriate processing of the pulse-to-pulse phase shift in the reflection of each of two wave trains that differ in one or both of the dimensions of interpulse period and carrier frequency. The processing is tantamount to a two-phase estimation procedure that is based on some properties of a collection of intervals of real numbers generated by two known speeds that serve as the moduli of distinct congruence relations. There is a connection between this procedure and the use of the Chinese remainder theorem in a multiple channel search system as a means for determining true slant range from several ambiguous range cell numbers. Author

N93-23419*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SIMULATION EVALUATION OF A LOW-ALTITUDE HELICOPTER FLIGHT GUIDANCE SYSTEM ADAPTED FOR A HELMET-MOUNTED DISPLAY
HARRY N. SWENSON, RICHARD E. ZELENKA, GORDON H. HARDY, and MUNRO G. DEARING Feb. 1992 15 p
(Contract RTOP 505-64-36)
(NASA-TM-103883; A-91219; NAS 1.15:103883) Avail: CASI HC A03/MF A01

A computer aiding concept for low-altitude helicopter flight was developed and evaluated in a real-time piloted simulation. The concept included an optimal control trajectory-generation algorithm based upon dynamic programming and a helmet-mounted display (HMD) presentation of a pathway-in-the-sky, a phantom aircraft, and flight-path vector/predictor guidance symbology. The trajectory-generation algorithm uses knowledge of the global mission requirements, a digital terrain map, aircraft performance capabilities, and advanced navigation information to determine a trajectory between mission way points that seeks valleys to minimize threat exposure. The pilot evaluation was conducted at NASA ARC moving base Vertical Motion Simulator (VMS) by pilots representing NASA, the U.S. Army, the Air Force, and the helicopter industry. The pilots manually tracked the trajectory generated by the algorithm utilizing the HMD symbology. The pilots were able to satisfactorily perform the tracking tasks while maintaining a high degree of awareness of the outside world. Author (revised)

N93-23509# Department of Transportation, Washington, DC.
THE ROLE OF GPS IN A FUTURE RADIONAVIGATION MIX: TRENDS IN THE 1992 US FEDERAL RADIONAVIGATION PLAN
HEYWOOD O. SHIRER *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 9-14 Jul. 1992
Copyright Avail: CASI HC A02/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

An overview of the role of GPS (Global Positioning System) in the future radio navigation mix is given and changes that might be expected in the 1992 U.S. Federal Radio navigation Plan (FRP) are examined. The GPS will have a significant impact on other radio navigation systems and will have a wide range of applications in aviation, marine, land, and non-navigation uses. The GPS SPS (Standard Positioning Service) was offered to ICAO (International Civil Aviation Organization) to form a practical starting point to begin acquiring the operational experience necessary for the development of a Global Navigation Satellite System (GNSS). Work has now begun to develop the policies and plans to be published in the 1992 FRP for GPS and other Federally provided radio navigation systems. ESA

N93-23513# Royal Geographical Society, London (England). Royal Inst. of Navigation.
A EUROPEAN RADIONAVIGATION PLAN?
D. W. BROUGHTON *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 33-35 Jul. 1992
Copyright Avail: CASI HC A01/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

A discussion on the possibility of a radio navigation plan for Europe is presented. Radio aids to navigation are indispensable for the safe and efficient transport of people and goods. It is unfortunate that the past 50 years have seen the uncoordinated development of such aid in Europe. This could be overcome by the adoption of a radio navigation plan similar to the U.S. Federal Radionavigation Plan which is jointly promulgated at two yearly intervals by the Departments of Defense and Transportation. The International Association of Institutes of Navigation has prompted the Council of the European Community to institute a European plan, and this is about to get under way. Such a plan needs to recognize plans in adjacent areas and indeed the sum of such plans could lead to a worldwide radio navigation plan. ESA

N93-23519# Beukers Technologies, Inc., Vero Beach, FL.
FINANCIAL ALTERNATIVES FOR GLOBAL SATELLITE NAVIGATION
JOHN M. BEUKERS *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 61-66 Jul. 1992
Copyright Avail: CASI HC A02/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

Military programs within the U.S. and the former U.S.S.R. were responsible for providing the technology and hardware for gobal satellite navigation. The Global Positioning System (GPS) from the U.S. is nearing operational status and is demonstrating the potential for gobal navigation and position location. Without radical change, the policies and structures of the institutions that are creating these systems are seen to be incompatible with the requirements and obligations of the international community. The financial impact of redirecting satellite navigation technology for civil use is explored. Alternatives to a single country providing satellite system financing and operation are discussed. A proposal for funding a global system is presented along with an organization that involves the special agencies of the United Nations. ESA

N93-23522# Racal Survey Ltd., London (England).
SKYFIX: A BETTER POSITION THROUGH THE USE OF INMARSAT AND GPS
G. A. H. MACK *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 81-86 Jul. 1992
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SkyFix is a satellite based DGPS (Differential Global Positioning System) service which uses the Inmarsat Marine Communications System as the datalink. SkyFix began operation in Aug. 1990, and its coverage is continuing to expand. Already SkyFix serves all the major offshore hydrocarbon exploration areas. The complementary application of two satellite systems and the synergy between them are described. The considerable infrastructure that is required for a comprehensive and professional DGPS system is discussed, and the gains in positioning service quality which can be achieved are demonstrated. ESA

N93-23523# Technische Univ., Brunswick (Germany). Inst. of Flight Guidance and Control.
PRECISE FLIGHT NAVIGATION BY INTEGRATION OF GLOBAL POSITIONING SYSTEM AND INERTIAL MEASUREMENT UNITS
STEFAN VIEWEG *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 87-92 Jul. 1992
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Realtime Differential GPS (Global Positioning System) offers precise positioning capabilities. This can be achieved by

combination of code and phase measurements with transmitted correction terms from a ground reference via link to the moving receiver e.g., in an aircraft. Although tight ICAO (International Civil Aviation Organization) limits for precision approaches or taxi guidance can be met, this system needs a complement to compensate insufficiencies, for example in dynamic maneuvers or total failure of position information due to satellite masking. Using International Measurement Units (IMU) with good dynamic characteristics but longterm drift as a result of misalignment, accelerometer and gyro errors, Kalman filter techniques are used to predict and eliminate these errors. Loss of GPS position due to jamming, satellite shadowing dynamic influences leads to a decreasing filter accuracy, if the GPS position is taken as reference (measurement vector) for the Kalman filter. Therefore a filter concept which is sustained by uncorrelated range and range rate measurements is discussed. Several investigations by means of simulation and flight tests show that the strategy chosen is able to perform precise position and attitude information. Even under dynamic environment with separated satellite masking an accuracy to meet the tight limits for precision approaches can be fulfilled. ESA

N93-23524# Niedersaechsisches Landesverwaltungsamt, Hanover (Germany). Abt. Landesvermessung.

A PERMANENT NEAR-ONLINE HIGH PRECISION POSITIONING SERVICE (HPPS) WITH GPS

WOLFGANG AUGATH *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 93-95 Jul. 1992

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The establishment and maintenance of nets of control points is a main task of the European Survey Agencies. For years DGPS (Differential Global Positioning System) has been used as an economic and precise method of measurement in this field. The problems with traditional nets of control points are described especially from the economic point of view. A proposal for a DGPS based High Precision Permanent Positioning Service (HPPS) on a +/- 1 cm level alternative to traditional control networks is given. The principle of a HPPS, open questions and the state of realization in northern Germany are described. The development of HPPS is supported by the German Space Agency. ESA

N93-23529# Centre National d'Etudes Spatiales, Toulouse (France).

TOWARDS GLOBAL SATELLITE NAVIGATION

J. M. DURAND *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 121-125 Jul. 1992

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The Global Positioning System (GPS) will offer extremely high navigation performance and has a promising future for most civil navigation neeeds. The GLONASS (Russian GPS) system is similar to GPS in its objectives. However, GPS and GLONASS have separately three major disadvantages for civil user: insufficient integrity, since many simultaneous users can obtain false positions and remain unaware of the problem; insufficient availability, since users can be unable to obtain a position fix or else can obtain a result with significantly degraded performance; for GPS only, deliberate spatio-temporal degradation ('selectice availability') of system performance, the characteristics of which are kept secret. Many solutions to these problems have been put forward. The comparison leads to the recommendation of a system to monitor the status of the GPS satellites and broadcast the information to users. The characteristics of such messages would be as similar as possible to those of GPS messages. Such a system is known as Geostationary Overlay, or GPS Integrity Channel (GIC) or European Complement to GPS (CE-GPS). These different points are developed and the status of the subsequent international coordination is considered. ESA

N93-23533# Inmos Ltd., Bristol (England).

AN INTEGRATED CAR NAVIGATION SYSTEM USING A SINGLE PROCESSOR FOR GPS SIGNAL PROCESSING, POSITIONING, MAP DISPLAY, AND REPORTING

PHILIP G. MATTOS *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 141-145 Jul. 1992

Copyright Avail: CASI HC A01/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

GPS (Global Positioning Systems) engines are now available at around 400 dollars. This is both too high for the car manufacturer, and too low to entice new players into the marine market. Integrating the application work into the GPS processor reduces costs by a very large margin, saving processor, ROM's (Read Only Memories), RAM (Random Access Memory) and interfacing. Novel map handling techniques, and low cost LCD (Liquid Crystal Displays), mean that the entire map display and GPS sensor can execute on the same CPU (Central Processing Unit). The position reporting role, where the driver has no display, is even simpler, as much of the work can be delegated to the central base station, allowing a single 16 bit transputer, with only a single ROM and no external RAM to fulfil the task. ESA

N93-23534# Maschinenfabrik Augsburg-Nuernberg A.G., Munich (Germany).

NAVSAT: AN APPLICATION OF GPS AND GLONASS FOR THE CIVIL USER COMMUNITY

MARTIN HAUNSCHILD, N. NIKLASCH, B. EISSFELLER (Kayser Threde G.m.b.H., Munich, Germany.), A. JANSCHE (Kayser Threde G.m.b.H., Munich, Germany.), J. MERKEL (Stuttgart Univ., Germany.), and W. SCHAEFER (Stuttgart Univ., Germany.) *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 147-152 Jul. 1992

Copyright Avail: CASI HC A02/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

NAVSAT is a civil complement to the satellite navigation systems NAVSTAR GPS (US Global Positioning System) and GLONASS (Russian GPS). Using these systems as a base with proven performance characteristics, the build up of a kernel system for a future civil satellite navigation system is intended. A proposal to solve the integrity problem of GPS and GLONASS for civil aviation requirements and to enhance the availability, coverage and accuracy is considered. These tasks will be attained by aid of small navigation payloads flown on suitable host satellites, using a navigation signal with a structure that is compatible to GPS and GLONASS, an appropriate ground segment for navigation signal uplink, satellite position determination, time transfer, communication and set of health minitoring units in the responsibility of national aviation authorities. In the future, this basic constellation may be augmented by additional geostationary and Tundra type satellites to achieve a global service. ESA

N93-23535# Kayser Threde G.m.b.H., Munich (Germany).

ON-LINE HEALTH MONITORING: AN INTEGRITY IMPROVEMENT FOR THE CIVIL USE OF GPS AND GLONASS

B. EISSFELLER, MARTIN HAUNSCHILD (Maschinenfabrik Augsburg-Nuernberg A.G., Munich, Germany.), A. JANSCHE, and N. NIKLASCH (Maschinenfabrik Augsburg-Nuernberg A.G., Munich, Germany.) *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 153-157 Jul. 1992

(Contract ESA(ESTEC)-9281/91)

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The development of an experimental Health Monitoring Unit (HMU) for GPS (Global Positioning System) and GLONASS (Russian GPS) is reported. The purpose of the HMU is to provide timely warnings to the navigation users of the satellite navigation systems if the satellite navigation systems are not used for

navigation. The monitoring unit is a key element in the integrity channel concept of a civil overlay NAVSAT to GPS and GLONASS. The most stringent requirements are those of civil aviation: in the nonprecision approach phase horizontal position errors exceeding the 600 m SPE thereshold have to be reported within 10 seconds. The concept of the HMU is to use a GPS receiver as well as a GLONASS receiver in a known location in order to detect large pseudorange errors and to identify the malfunctioning satellites. This means that the station is able to work autonomously. It will also provide pseudorange errors compatible with the American RTCA SC-159 approach and for a future wide area DGPS (Differential GPS) system. ESA

N93-23587 Texas Univ., Austin.
PRECISE GPS-BASED TRACKING OF REMOTE SENSING SATELLITES Ph.D. Thesis
GEORGE EDWARD POWELL, JR. 1992 254 p
Avail: Univ. Microfilms Order No. DA9239337

The Global Positioning System (GPS), when fully deployed, will make possible an entirely new, geometric method of precise orbit determination. The geometric approach requires continuous collection of pseudorange measurements from at least four GPS satellites, and simultaneous acquisition of carrier phase data for pseudorange smoothing. While the GPS satellite orbits are determined utilizing the classical technique, within the geometric framework, no force model representation for the user satellite is required. However, in spite of the dynamic modeling related benefits of geometric tracking, this non-dynamic technique has its own measurement liabilities. The geometrically determined orbit is extremely sensitive to the observing geometry, clock errors, accuracy of the GPS ephemerides, and other measurement error sources such as signal multipath. Therefore, a hybrid, reduced-dynamic, method has been formulated which utilizes both measurement and dynamic information for the low satellite and weights the dynamic information relative to the geometric by compensating for process noise in the user satellite force mode. For sigma(i) approaches 0 and sigma(i) approaches infinity, where sigma(i) is the steady state uncertainty in the process noise for the i-th batch interval, the state of the user satellite with respect to a reference dynamic orbit is estimated purely dynamically or purely kinematically, respectively. The focus of this work is the determination of realistic orbit errors for GPS-based reduced-dynamic tracking of remote sensing satellites including the Earth Observing System (EOS), and the Ocean Topography Experiment (TOPEX). Comprehensive error models were developed for GPS-based tracking of TOPEX and EOS, and the Orbit Analysis SImulation Software (OASIS) was modified to simulate reduced-dynamic tracking of these satellites. The orbits of both the GPS and user satellites were estimated by processing undifferenced pseudorange and carrier phase information. Each transmitter and receiver clock was estimated as a white noise process noise parameter, and constant phase biases were computed for each transmitter-receiver pair per pass. Simulations were combined with consider covariance analysis to determine realistic TOPEX and EOS orbit errors. The reduced-dynamic tracking technique is examined from a dynamic perspective. The benefits of estimating clock parameters rather than eliminating them is discussed, especially as it relates to science support and intercontinental time transfer. Comparisons between dynamic, kinematic, and reduced-dynamic tracking and their associated performance are presented along with recommendations for future research. Dissert. Abstr.

N93-24105 Civil Aviation Authority, London (England).
TCAS 2: REPORT ON UK OPERATIONAL TRIAL
DAVID A. HOWSON May 1992 117 p Original contains color illustrations
(CAA-PAPER-92011; ISBN-0-86039-5219; ETN-93-93566)
Copyright Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, United Kingdom, HC

The UK (United Kingdom) operational trial of TCAS 2 (Traffic Alert and Collision Avoidance System) is reported. Pretrial activities, data collection, and data analysis of airborne and ground radar recording are described. Events of interest are discussed. In TCAS terms, the quantity of data collected during the trial is recognized to be comparatively small. Therefore, great care was taken in analyzing the results to try to avoid reading too much into the data. However, some significant and obvious trends are identified. The main features of the RA (Resolution Advisories) and TA (Traffic Advisories) data are described. The implications of TCAS as they may affect aircraft operators, UK ATC (Air Traffic Control) providers, and the Safety Group of the UK CAA (Civil Aviation Authority), are discussed. ESA

N93-24138# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Abt. Systemtechnik und Navigation.
TESTING OF A GPS RECEIVER GLOBUS AN 2000 OF SEL: A STUDY OF SELECTIVE AVAILABILITY [FLUGERPROBUNG EINES GPS-EMPFAENGERS GLOBUS AN 2000DER FIRMA SEL: UNTERSUCHUNG VON 'SELECTIVE AVAILABILITY']
HANS-PETER ZENZ Apr. 1992 40 p In GERMAN
(ISSN 0939-298X)
(DLR-MITT-92-07; ETN-93-93523) Avail: CASI HC A03/MF A01; DLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

The development of the GPS (Global Positioning System) has been continuing since the early seventies. During the test period from May to Jul. 1991 15 satellites were available for navigation purposes. For flight testing of the GPS, a GPS receiver (GLOBOS AN 2000) was mounted in an aircraft DO 228. The reference trajectories were determined by the Avonics Flight Evaluation System (AFES). The effect of 'selective availability' is shown in several test series. ESA

N93-24222# Department of the Navy, Washington, DC.
RELATIVE MOTION PINWHEEL Patent Application
GARY E. STREINER, inventor (to Navy) and LESLIE P. BENDA, inventor (to Navy) 5 Oct. 1992 13 p
(AD-D015629; US-PATENT-APPL-SN-956327;
NAVY-CASE-73981) Avail: CASI HC A03/MF A01

An apparatus for visualizing relative motion between two moving objects in a two-dimensional plane is provided. A planar base has a first compass rose printed thereon. Rotatably attached to the center of the first compass rose is a means for indicating a present course of a first moving object relative to a true bearing indication on the first compass rose. A second moving object assembly consists of a second compass rose rotatably attached to a means for indicating a present course of the second moving object relative to a true bearing indication on the second compass rose. The true bearing indication on the second compass rose is aligned to be equivalent to the true bearing indication on the first compass rose. Attached at the centers of the first and second compass roses is a means for tethering the second moving object assembly to the first compass rose. The second compass rose is free to rotate about its center and the second moving object assembly is free to revolve in a single-plane around the center of the first compass rose. The tethering means indicates a line of relative bearing from the first moving object to the second moving object. GRA

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A93-30897#
ACSYNT AERODYNAMIC ESTIMATION - AN EXAMINATION AND VALIDATION FOR USE IN CONCEPTUAL DESIGN
W. H. MASON and T. K. ARLEDGE (Virginia Polytechnic Inst. and State Univ., Blacksburg) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19,

1993 Research supported by Virginia Polytechnic Inst. and State Univ refs
(AIAA PAPER 93-0973) Copyright

The aerodynamic prediction methodology available in ACSYNT is examined through comparison with aircraft data for a variety of classes of configurations. The predictions are a synthesis of the best empirical procedures currently available. The paper presents selected results obtained from the comparison, and shows how the basic capability can be enhanced by user supplied adjustments to represent changes in technology levels when considering advanced aircraft designs. The predictions and basis for adjustments are described for a supersonic cruise vehicle (the XB-70), a large subsonic transport, and a typical fighter. Author

A93-30943*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DESIGN OF HIGH SPEED PROPROTORS USING MULTIOBJECTIVE OPTIMIZATION TECHNIQUES
THOMAS R. MCCARTHY and ADITI CHATTOPADHYAY (Arizona State Univ., Tempe) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(Contract NAG2-771)
(AIAA PAPER 93-1032) Copyright

A multidisciplinary optimization procedure is developed for the design of high speed proprotors. The objectives are to simultaneously maximize the propulsive efficiency in high speed cruise without sacrificing the rotor figure of merit in hover. Since the problem involves multiple design objectives, multiobjective function formulation techniques are used. A derailed two-celled isotropic box beam is used to model the load carrying member within the rotor blade. Constraints are imposed on rotor blade aeroelastic stability in cruise, the first natural frequency in hover and total blade weight. Both aerodynamic and structural design variables are used. The results obtained using both techniques are compared to the reference rotor and show significant aerodynamic performance improvements without sacrificing dynamic and aeroelastic stability requirements. Author

A93-30945#
INFLUENCE OF FREQUENCY CONSTRAINTS AND DESIGN VARIABLE LINKING ON MULTIDISCIPLINARY STRUCTURAL OPTIMIZATION OF A FIGHTER WING
A. G. STRIZ and P. R. ALLURI (Oklahoma Univ., Norman) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1037) Copyright

This paper presents an investigation into various aspects of the behavior of multidisciplinary structural weight optimization, here, using the widely distributed computer code ASTROS, the Automated Structural Optimization System. The influence of multiple constraints, specifically of the natural frequencies of the lowest free vibration modes together with the flutter speed, on the optimal redesign of a low aspect ratio fighter wing is evaluated. The wing structure is fully built-up from finite elements with sizes and member locations selected to realistically model the wing. This initial model is optimized for strength in a 9-g pull-up to obtain minimum sizes for all design variables, i.e., minimum element sizes, for the ensuing free vibration and flutter optimization. Then, the two lowest free vibration frequencies and the flutter speed are used simultaneously as constraints and the behavior of the optimization is traced from iteration to iteration up to convergence. Two different design variable linking schemes are employed. It is demonstrated that the optimization procedure in ASTROS performs smoothly from iteration to iteration and from the first to the last iteration of an optimization run without large changes in the design variables and the variables to be constrained. These findings should increase confidence in the use of multidisciplinary optimization codes such as ASTROS in the preliminary design process. Author

A93-30946#
DESIGN OF A TILTROTOR UNMANNED AIR VEHICLE FOR MARITIME APPLICATIONS
W. THARP, R. MORGAN, and J. P. MAGEE (Bell Helicopter Textron, Inc., Fort Worth, TX) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1040) Copyright

The characteristics and the details of the design of a tilt-rotor unmanned air vehicle (the Eagle Eye vehicle) for maritime applications are described, and the vehicle's anticipated capability is discussed. Particular attention is given to the vehicle's requirements and design parameters and the design and specifications of the Eagle Eye demonstration vehicle. The demonstration vehicle will need to be further developed to provide an optimum design for application to fleet service. The paper presents design diagrams of the Eagle Eye and the dimensional data specifications for the demonstrator. I.S.

A93-30947#
THE V-22 WING STOW SYSTEM - DESIGN AND FABRICATION FOR COST REDUCTION
WILLIAM E. RUMBERGER (Boeing Defense and Space Group, Helicopters Div., Philadelphia, PA) Feb. 1993 6 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1041) Copyright

The paper describes a method for producing the 'least part count' design and discusses the importance of least part count design as a basis for creating a product cost reduction, with the V-22 Wing Stow system design taken as an example. The items discussed include selling the design concept, the design concept tools, structural analysis with NASTRAN, the risk reduction and cost reduction considerations, the 'crushable stop', the choice of the least mechanism as the best mechanism, the material selection and fabrication, and the choice of best tools for the design definition to reduce cost. I.S.

A93-30948#
MD EXPLORER - CUSTOMER FOCUS COMBINES ADVANCED DESIGN METHODS
PHILIP J. ALLDRIDGE and VIRGIL R. KAHLER (McDonnell Douglas Helicopter Co., Mesa, AZ) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1042) Copyright

The MD Explorer, previously known as the MDX, is a light twin-turbine-powered helicopter which incorporates such advanced design features as the NOTAR antitorque system, a five-bladed hingeless composite rotor system, energy absorbing seats and structure, and an integrated instrument display system. This paper describes the methods used for the design of the MD Explorer, which focused on the incorporation of customers' requirements into advanced design methods. Particular attention is given to the list of customer requirements, the CAD and the 3D model used as the master, the electronic development fixture (EDF) and its development, and the EDF usage for customer support (being a database of all component configurations, the EDF has the ability to reflect a particular ship configuration). I.S.

A93-30992#
ULTRA-HIGH CAPACITY AIRCRAFT - SOME DESIGN CONSIDERATIONS
RAY WHITFORD (Royal Military College of Science, Shrivenham, United Kingdom) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Research supported by British Council refs
(AIAA PAPER 93-1108) Copyright

A feasibility study of ultra-high capacity aircraft carried out at Royal Military College of Science, Shrivenham, England, is presented. The design configurations of 600-700 seat tri-class airliners are described focusing on cabin design; layout and provision for enhanced passenger services and evacuation;

infrastructure constraints, including runways/taxiways/docking gate capability; and costs. It is concluded that the technology required to design and built such an aircraft is available today. Such aircraft is considered to offer the only foreseeable way ahead to combat the increasingly severe restraints imposed by airport and ATC facilities and the demands of airlines to be able to offer improved passenger amenities at lower cost. O.G.

A93-30993*# National Aeronautics and Space Administration, Washington, DC.
THE DESIGN OF A LONG RANGE MEGATRANSPORT AIRCRAFT
T. A. WEISSHAAR, J. B. LAYTON, and C. L. ALLEN (Purdue Univ., West Lafayette, IN) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Research supported by NASA and Universities Space Research Association refs
(AIAA PAPER 93-1109) Copyright

Megatransport objectives and constraints are briefly reviewed, and certain solutions developed by student design teams at Perdue University are summarized. Particular attention is given to the market needs and the economic risks involved in such a project; and the different approaches taken to solve the problem and difficulties faced by the design teams. A long range megatransport aircraft is aimed at carrying more than 600 passengers at reduced cost, and at the same time, reducing airport and airway congestion. The design effort must take into account airport terminal facilities; passenger loading and unloading; and defeating the 'square-cube' law to design large structures. O.G.

A93-31025#
DESIGN AND EFFECTIVENESS EVALUATION OF AN ACTIVE VIBRATION ISOLATION SYSTEM FOR A COMMERCIAL JET AIRCRAFT
DOUGLAS A. SWANSON and LANE R. MILLER (Lord Corp., Thomas Lord Research Center, Cary, NC) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1145) Copyright

This paper discusses the advantages of active isolation systems for aerospace applications using a Douglas DC-9 engine mounting system as a case study. Isolation systems reduce interior cabin noise by preventing engine vibration from reaching the aircraft structure. Recently developed active isolation systems offer significant performance improvements over currently used passive isolators and hard mounts. The relative performance of active, passive, and hard mounts are expressed using a mount effectiveness model, which also relates the tradeoffs encountered in mount design. The results of a case study for the DC-9 aircraft clearly show that active isolation systems can achieve significant vibration reductions versus passive isolation systems without increasing engine motion. Author

A93-31035#
YF-23 LEADING EDGE FLAP AND WEAPONS BAY DOOR HYDROMECHANICAL DRIVE SYSTEMS
W. C. SAINIO (Allied-Signal Aerospace Co., Torrance, CA) and B. A. KRANDEL (Sundstrand Aerospace, Mechanical Systems Div., Rockford, IL) Feb. 1993 9 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1162) Copyright

The YF-23 leading edge flap (LEF) system had an independently driven flap on each wing; these were identical and not mechanically linked. An electronically controlled, overcenter, variable-displacement hydraulic motor in the power drive unit (PDU) responded to commanded positions from the aircraft controller. Wing bending interaction loads were decoupled from the system gear drive units (GDUs), virtually eliminating induced side loading and providing pure torque out of the GDUs. A PDU secondary drive was used in an emergency mode if a primary drive torque shaft failed. A torque monitor provided secondary load path enhancement and failure annunciation. A flap stop prevented overtravel due to failure in position control. The door actuation system (DAS) had two independently driven doors, not mechanically linked. Door and spoiler motion was controlled by a servocontroller (part of the DAS). A spoiler for each door was mechanically sequenced with door movement. Both component fatigue and system-level tests were conducted on the LEF actuation system, while testing of the DAS was limited to component tests and computer-simulated system development. Author

A93-31036#
MD-11 VACUUM WASTE SYSTEM AIR FLOW ANALYSIS
W. S. CHAO (McDonnell Douglas Corp., Long Beach, CA) Feb. 1993 9 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1163) Copyright

Attention is given to a transient air flow simulation model for analyzing a variety of conditions which can be encountered in service. The system's parameters, methods and assumptions used in the computation, and correlations between analytical simulation and flight test data are described. The transient analysis shows that the steady state air flow testing will underestimate peak air flow, and therefore lavatory noise. It is also shown that transient air flow rate is dependent on the amount of available air volume inside the storage tank and is not sensitive to the size of the orifice used to restrict air flow to minimize noise. The basic model can be adapted for analysis of other similar vacuum waste systems. P.D.

A93-31043*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
BENEFITS ASSOCIATED WITH ADVANCED TECHNOLOGIES APPLIED TO A HIGH-SPEED CIVIL TRANSPORT CONCEPT
L. P. OZOROSKI, E. W. SHIELDS (Lockheed Engineering & Sciences Co., Hampton, VA), J. W. FENBERT, and M. O. MCELROY (NASA, Langley Research Center, Hampton, VA) Feb. 1993 9 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1173) Copyright

Results of a first-order assessment of the mission performance benefits associated with the technology improvements and goals of the Phase II High-Speed Research (HSR) Program are presented. A breakdown of the four major disciplines resulted in the following estimated TOGW savings from the 1990 vehicle: propulsion at 14.3 percent, structures at 11.7 percent, flight-deck systems at 4.0 percent, and aerodynamics at 15.0 percent. Based on 100 percent success of the HSR Phase II proposed technology advancements, the overall combined impact is estimated to result in a 45 percent reduction in TOGW from a 1990 entry-into-service (EIS) date, which could result in a viable 2005 EIS vehicle with an acceptable TOGW that meets Stage III community noise restrictions. Through supersonic laminar flow control and the possible reduction in reserve fuel requirements resulting from synthetic vision capability, the potential exists for an additional 9.6 percent reduction in TOGW. P.D.

A93-31045#
CANARD ROTOR/WING - A REVOLUTIONARY HIGH-SPEED ROTORCRAFT CONCEPT
JOHN W. RUTHERFORD, STEVEN M. BASS, and STEVEN D. LARSEN (McDonnell Douglas Helicopter Co., Mesa, AZ) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1175) Copyright

McDonnell Douglas Helicopter Company is currently developing a revolutionary highspeed rotorcraft which promises high-speed capability, coupled with the ability to take off and land vertically. This concept is suitable as an unmanned aerial vehicle (UAV) to fulfill the requirements of the VTOL UAV mission and as a candidate for a future ground attack vehicle. The concept, known as the Canard Rotor/Wing (CRW) uses a warm cycle, reaction driven rotor for rotary-wing flight. At conversion speed, the canard and lifting horizontal tail reduce the rotor thrust to zero, allowing the rotor to be stopped. The vehicle continues flying as a three-surface

aircraft as the gases from the turbofan engine are diverted aft, providing very high speed capability. Author

A93-31046*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ASSESSMENT OF MISSION AND CONFIGURATION VARIATIONS ON MULTI-ROLE FIGHTER/ATTACK AIRCRAFT CONCEPTS
MICHAEL J. LOGAN (NASA, Langley Research Center, Hampton, VA) and WILLIAM W. SHEPLER (PRC, Inc., Edwards AFB, CA) Feb. 1993 8 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1177) Copyright

This paper presents the results of a series of configuration studies conducted in connection with the NASA agility design study project. The purpose of these in-house studies was to develop a parametric data base of configuration concepts and resulting mission performances for a variety of notional fighter/attack missions. This data base will then be used to assess the impact of the imposition of agility requirements on these configurations. Three vehicle concepts were evaluated, and resulting vehicle sizes, weights, and mission performances were compared. Each configuration was then optimized for varying mission requirements and technology levels. It was found that small variations in mission requirements can have significant impact on the design choices. It was also found that optimization of engine cycle variables results in significant improvements in take-off gross weight and vehicle performance regardless of the concept being explored. Finally, results indicate that signature considerations such as internal vs. external weapons carriage can cause dramatic changes in vehicle size, weight, and mission performance. Author

A93-31047*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TECHNOLOGY BENEFITS FOR VERY LARGE SUBSONIC TRANSPORTS
PHILIP C. ARCARA, JR., DENNIS W. BARTLETT (NASA, Langley Research Center, Hampton, VA), MARVIN E. MCGRAW, JR., and KARL A. GEISELHART (Lockheed Engineering & Sciences Co.; NASA, Langley Research Center, Hampton, VA) Feb. 1993 16 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1178) Copyright

Results are presented for a study conducted at the NASA Langley Research Center which examined the effects of advanced technologies on the performance and size of very large, long-range subsonic transports. The study was performed using the Flight Optimization System (FLOPS). a multidisciplinary system of computer programs for conceptual and preliminary design and evaluation of advanced aircraft concepts. A four-engine, baseline configuration representative of existing transport technology was defined having a payload of 412 passengers plus baggage and a design range of 7300 nmi. New 600, 800 and 1000-passenger advanced transport concepts were then developed and compared to the baseline configuration. The technologies examined include 1995 entry-into-service (ELS) engines, high aspect ratio supercritical wings, composite materials for the wing, fuselage and empennage, and hybrid laminar flow control (HLFC). All operational and regulatory requirements and constraints, such as fuel reserves, balanced field length, and second segment climb gradient were satisfied during the design process. The effect of the advanced technologies on the size, weight and performance of the advanced transport concepts are presented. In addition, the sensitivity of the takeoff gross weight of the advanced transport concepts to increases in design range and payload, and designing for stretch capability are also discussed. Author

A93-31048#
TESTING FOR DESIGN VALIDATION OF BK117 FBW EXPERIMENTAL HELICOPTER
TAKESHI TOMIO, MUNENORI ISHIKAWA, MINORU WATARI, SHUJI NAKAMURA, and TAKAAKI TAIRA (Kawasaki Heavy Industries, Ltd., Gifu, Japan) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1179) Copyright

The paper describes the design of the fly-by-wire (FBW) system developed for the BK117 FBW Experimental Helicopter, and presents results of tests, which were carried out at each phase of the FBW helicopter development to confirm the functions and the performance of both the FBW system and equipments, and their airworthiness. Prior to the beginning of the flight test, the FBW system and helicopter equipment were integrated in a flight simulation test using the actual BK117 FBW Experimental Helicopter, which was accommodated on the flight simulation facility. I.S.

A93-31056#
INTEGRATED POWER UNIT FOR A MORE ELECTRIC AIRPLANE
PHILLIP G. COLEGROVE (USAF, Wright Lab., Wright-Patterson AFB, OH) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1188)

A major thrust for power technology for aircraft is the development of a secondary power unit for the More Electric Aircraft (MEA). The MEA concept involves replacing selected aircraft hydraulic, pneumatic, and mechanical power distribution subsystems with electrical subsystems. As part of the approach to the MEA, an Integrated Power Unit (IPU) is being developed which will provide electric power for main engine starting and for in-flight emergency power, as well as for normal auxiliary power functions. Thus, the IPU combines the functions of the main engine starting system, emergency power unit, and auxiliary power unit into a single component. This can result in significant savings in hardware weight as well as increased reliability and maintainability. The technical issues involved include the integration of a direct-drive electric starter/generator with the turbomachinery, non-lubricated bearings, multimode (airbreathing and non-airbreathing) operation, fault tolerance, and thermal management and control. The considerations which must be taken into account in solving these design problems are discussed. Author

A93-31164
APPROXIMATE ESTIMATION OF THE FATIGUE DAMAGE OF AN AIRFRAME DURING SERVICE [PRIBLIZHENNAIA OTSENKA USTALOSTNOI POVREZHDAEMOSTI PLANERA SAMOLETA V USLOVIIAKH EKSPLUATATSII]
V. M. ADROV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 58-61. In Russian. refs
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A method for the approximate calculation of the equivalent accrued flight hours for the critical sections of the structural elements of airframes is proposed which is based on the use of stress repetition curves. The expressions proposed here do not require complex mathematical calculations or any special training of the personnel. The method is illustrated by an example. V.L.

A93-31625
THE MIDDLE GROUND
HARRY HOPKINS Flight International (ISSN 0015-3710) vol. 143, no. 4355 Feb. 3, 1993 p. 26-30.
Copyright

A flight performance evaluation is presented for the Saab 2000 twin-turboprop commuter airliner, which is undergoing certification trials. The 2000, which is a development of the smaller Saab 340 commuter airliner, employs electronic flight-instrument system displays and full-authority digital engine control. A cutaway drawing of the aircraft is presented. O.C.

A93-31778
THREE-DIMENSIONAL SIMULATION OF ELECTROTHERMAL DEICING SYSTEMS
ALAN D. YASLIK, KENNETH J. DE WITT, THEO G. KEITH, JR. (Toledo Univ., OH), and WALTER BORONOW (McDonnell Douglas

Corp., Long Beach, CA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1035-1042. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0267. Previously cited in issue 07, p. 982, Accession no. A91-21433 Research supported by McDonnell Douglas Corp refs
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A93-31781
NUMERICAL MODELING OF AN ADVANCED PNEUMATIC IMPULSE ICE PROTECTION SYSTEM FOR AIRCRAFT
SUBRAMANIAM RAMAMURTHY, THEO G. KEITH, JR., KENNETH J. DE WITT (Toledo Univ., OH), JAMES C. PUTT, CHARLES A. MARTIN, and KEVIN L. LEFFEL (BF Goodrich Aerospace, Uniontown, OH) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1057-1063. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0555. Previously cited in issue 07, p. 982, Accession no. A91-21529 refs
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A93-31934
AERODYNAMIC EFFECTS OF GROUND DE/ANTI-ICING FLUIDS ON FOKKER 50 AND FOKKER 100
J. VAN HENGST (Fokker Aircraft, Amsterdam, Netherlands) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 35-40. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0785. Previously cited in issue 07, p. 983, Accession no. A91-21617 refs
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A93-31947
AEROELASTIC TAILORING ANALYSIS FOR PRELIMINARY DESIGN OF ADVANCED PROPELLERS WITH COMPOSITE BLADES
TAKASHI YAMANE (Mechanical Engineering Lab., Tsukuba, Japan) and PERETZ P. FRIEDMANN (California Univ., Los Angeles) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 119-126. AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 31st, Long Beach, CA, Apr. 2-4, 1990, Technical Papers. Pt. 3, p. 1773-1781. Previously cited in issue 11, p. 1614, Accession no. A90-29395 refs
Copyright

A93-31948
FASTEST CLIMB OF A TURBOJET AIRCRAFT
SHIVA K. OJHA (Indian Inst. of Technology, Bombay, India) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 127-129.
Copyright
The basic relations of climb performance are discussed, and the expressions for airspeed, climb angle, and rate of climb are given. These relations are used to obtain analytical expressions for the endurance, range, and climb-fuel weight fraction during the fastest climb range. The analysis is applied to a turbojet aircraft of wing loading 2873 N/sq m. AIAA

A93-31957
FASTEST CLIMB OF A PISTON-PROP AIRCRAFT
SHIVA K. OHJA (Indian Inst. of Technology, Bombay, India) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 146-148.
Copyright
An improved analysis of fastest climb is presented, and analytical expressions are obtained for horizontal distance covered, time taken, and fuel consumed during the fastest climb. This is useful in performance calculations for the preliminary design of a piston-prop aircraft. The analysis is applied to a piston-prop aircraft with a total weight of 7350 N and an engine power of 75 kW. AIAA

A93-31959
TOTAL LEAST SQUARES ESTIMATION OF AERODYNAMIC MODEL PARAMETERS FROM FLIGHT DATA
MARTIN LABAN and KAZUYA MASUI (Delft Univ. of Technology, Netherlands) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 150-152. refs
Copyright
Total least squares (TLS) estimation has been introduced in the field of aircraft parameter identification. Accurate accounting for multiple sources of (random) errors in a flight test instrumentation system is shown to be its advantage. Unlike least squares estimation, TLS was shown to yield realistic predictions of the standard deviations of its estimates. AIAA

A93-32173
PROBLEMS IN THE DESIGN OF HELICOPTER ROTORS [PROBLEMY PROEKTIROVANIIA NESUSHCHIKH VINTOV VERTOLETOV]
A. A. BADIAGIN, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 72 p. In Russian. For individual items see A93-32174, A93-32175, A93-32177, A93-32178, A93-32180, A93-32181
Copyright
The papers presented in this volume address various problems in the aerodynamics, dynamics, and strength of helicopter rotors, including hingeless rotors and circulation-control rotors. In particular, attention is given to the estimation of drive power requirements for hingeless rotors with a cyclically varying blade pitch at the design stage; a method for calculating the spatial position of a vortex wake behind coaxial helicopter rotors; and experimental studies of air flow in the channel of a circulation-control rotor blade. Other topics discussed include a method for calculating the dynamic characteristics of a rotor blade; development of CAD data bases for the helicopter rotor blade; and the optimal largest diameter of the helicopter rotor. AIAA

A93-32174
ESTIMATION OF DRIVE POWER REQUIREMENTS FOR HINGELESS HELICOPTER ROTORS WITH A CYCLICALLY VARIABLE BLADE PITCH AT THE DESIGN STAGE [OTSENKA POTREBNOI MOSHCHNOSTI DLIA PRIVODA BESSHARNIRNYKH NESUSHCHIKH VINTOV S TSIKLICHESKI IZMENIAEMYM SHAGOM LOPASTEI NA ETAPE PROEKTIROVANIIA]
B. L. ARTAMONOV *In* Problems in the design of helicopter rotors Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 5-10. In Russian. refs
Copyright
The paper is concerned with the phenomenon of torque changes resulting from the cyclic variation of the rotor blade pitch. For a quantitative analysis of this phenomenon, simple analytical expressions are obtained for the inductive power coefficient of a hingeless rotor with an azimuthally varying angle of blade stoppage in the hover mode. The formulas are derived in the context of generalized disk vortex theory of the rotor. Calculations of the aerodynamic characteristics of a two-blade rotor are presented as an example, and the results are compared with experimental data. AIAA

A93-32178
METHODS FOR CALCULATING THE DYNAMIC CHARACTERISTICS OF A ROTOR BLADE [METODY RASCHETA DINAMICHESKIKH KHARAKTERISTIK LOPASTI NESUSHCHEGO VINTA]
I. A. LEVIN *In* Problems in the design of helicopter rotors Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 31-51. In Russian. refs
Copyright
The problem of determining the natural frequencies and modes of a rotor blade using the finite element method is reduced to that of determining the eigenvalues and vectors of a symmetric matrix. This approach makes it possible to allow for the blade root mounting angle, blade twist, and various blade fastening

configurations. Methods are also presented for determining the stability, frequencies, and modes of blades in air in the axial rotor operation regime as well as blade loads and the flutter threshold in high-velocity flight. AIAA

A93-32181
OPTIMAL LARGEST DIAMETER OF THE HELICOPTER ROTOR BLADE [OPTIMAL'NYI NAIBOL'SHII DIAMETR NESUSHCHEGO VINTA VERTOLETA]
V. R. MIKHEEV *In* Problems in the design of helicopter rotors Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 60-67. In Russian. refs
Copyright

The problem of the optimal largest diameter of the rotor blade is examined from a historical perspective. It is noted that, historically, the development of new materials made it possible to increase the optimal maximum diameter of rotors by a factor of 1.5-2. It is expected that the transition to new composite materials will make it possible to increase the rotor diameter to 50-60 m, thus achieving a load-bearing capacity in excess of 100 t while retaining the single-rotor configuration. AIAA

A93-32393
TECHNICO-PHYSICAL LIMITS OF ROTOR SYSTEMS
M. HANCART (Aerospatiale, Div. Helicopteres, Marignane, France) *In* International Helicopter Forum, 18th, Bueckeburg, Germany, May 16, 17, 1990, Reports Bueckeburg, Germany International Helicopter Center 1990 p. 47-82.
Copyright

The question of the physical limitation in forward flight of a helicopter main rotor is addressed along with the issue of the optimization level that can be applied for commercial operation without overdegrading the rotor's optimization in hover. Optimization criteria in hover are reviewed and aerodynamic parameters relevant to main rotor optimization are discussed, including blade twist, airfoils, blade tips, and advanced planforms. The problem of noise is briefly considered and hub technology is briefly examined. Finally, the problem of vibration is addressed. AIAA

A93-32692
A MICROCOMPUTER PROGRAM SYSTEM FOR SEAPLANE FLOAT CONTOUR DESIGN
XIAOQUN SONG (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 57-67. In Chinese. refs

This paper introduces a microcomputer program system for seaplane float contour design system - FCDS. A float contour is a complex 3D curved surface which must satisfy some requirements about hydrostatical and hydrodynamical performances. A nonuniform rational B-spline is adopted to fit the cross designed curves and surfaces, on which not only the multiple-knot and multiple-vertex techniques based on a common polynomial nonuniform B-spline can be inherited, but also the ability of regulating shape will be increased. Besides, conics and conicoids can be integrated into a cubic rational expression. In the system, the function of fairing space curves and surfaces with the Hosaka method has been designed and the float contour can be faired so as to provide the contour data for direct application to manufacture. The design conception and the structural form of CAD systems for specialized surface design such as FCDS are discussed. Author (revised)

A93-32698
A STUDY ON THE KINEMATICS OF HELICOPTERS IN LOOP AND ROLL MANEUVERS
YIHUA CAO and ZHENG GAO (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 117-123. In Chinese. refs

The kinematics of helicopters in loop and roll maneuvers is analyzed in this paper. The mathematic model equations, boundary conditions, and nonlinear iterative algorithm established herewith can be used to calculate the variations of flight path, velocity (or angular velocity), acceleration as well as load factor, etc., with time for the said maneuvers. Finally, a sample calculation is shown. The study accomplished in this paper not only can lay the foundations for studies of flight dynamics of helicopters during maneuvering flight, but also are of practical significance in aerobatic application to armed helicopters. Author (revised)

A93-32745
A PRACTICAL AIRCRAFT STRUCTURAL MONITORING SYSTEM
MARK N. WEST, ROBERT L. FONDA, and AMIYA K. CHATTERJEE (Mission Research Corp., Survivable Structures and Technologies Div., Costa Mesa, CA) *In* Smart structures and materials; Proceedings of the Symposium, 112th ASME Winter Annual Meeting, Atlanta, GA, Dec. 1-6, 1991 New York American Society of Mechanical Engineers 1991 p. 173-177. Research supported by Northrop Corp refs
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A novel aircraft structure monitoring system has been developed within the framework of the USAF Aircraft Structural Integrity Program with a view to more accurate aircraft tracking for crack growth analysis, improved safety via monitoring of flight-critical structural components, and the ability to tailor the system to the unique requirements of each aircraft through a readily expandable modular design. The present monitoring system is applied to fighter aircraft wing root trunnions, the dorsal longeron, lower wing skins, control surface hinges, and the horizontal stabilator actuator mount. AIAA

A93-32954
AIR FRAME CONSIDERATIONS IN FUEL THERMAL STABILITY FOR COMMERCIAL SUPERSONIC FLIGHT
JOHN E. SCHMIDT (Boeing Commercial Airplane Group, Seattle, WA) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 34-53. refs
Copyright

Airframe fuel system thermal environments for anticipated supersonic flight in the Mach 2.0 to Mach 4.5 range are calculated and discussed. Aerodynamic heating can result in tank fuel temperatures as high as 100 C, and airframe cooling requirements may raise the temperature at the engine pump inlet by another 50 C. Results of earlier tests on formation of fuel deposits in tanks show tank deposits to be inconsequential for speeds below Mach 3.0, although verification of this for nonmetallic tank materials and current fuels is recommended. Adaptions to fuel thermal stability specifications and testing may be required for supersonic flight. These could include higher specification test temperature limits, extended residence time or recirculation in the thermal stability test section, heat presoaking of fuel test samples, and elimination of prefiltering before the test section. Development of a test for the formation of fuel tank deposits may be required if speeds above Mach 3.0 are anticipated. Author

A93-32955
HIGH TEMPERATURE FUEL REQUIREMENTS AND PAYOFFS
BENNETT M. CROSWELL and TEDD B. BIDDLE (Pratt & Whitney Group, West Palm Beach, FL) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 57-72. Research supported by USAF
Copyright

Results are presented of an experimental study of the temperature capability requirements of the fuel for future tactical fighter applications and the payoffs that would be realized by achieving these capabilities. The approach was to determine the maximum benefit that might be realized through the use of high-temperature fuels, by eliminating the recirculation system. Heat loads were projected for different missions spanning the Integrated High-Performance Turbine Engine Technology phases I, II, and III at different flight conditions, making calculations of fuel temperatures across the fuel system components at these flight

conditions. The results indicated that the elimination of the recirculation system is not feasible. It is shown, however, that high temperature fuel capability can minimize the weight penalty associated with fuel recirculation. AIAA

A93-33111* National Aeronautics and Space Administration, Washington, DC.
HYDROGEN AIRCRAFT TECHNOLOGY
G. D. BREWER (Lockheed-California Co., Burbank) Boca Raton, FL CRC Press 1991 441 p. refs
(ISBN 0-8493-5838-8) Copyright

A comprehensive evaluation is conducted of the technology development status, economics, commercial feasibility, and infrastructural requirements of LH2-fueled aircraft, with additional consideration of hydrogen production, liquefaction, and cryostorage methods. Attention is given to the effects of LH2 fuel cryotank accommodation on the configurations of prospective commercial transports and military airlifters, SSTs, and HSTs, as well as to the use of the plentiful heatsink capacity of LH2 for innovative propulsion cycles' performance maximization. State-of-the-art materials and structural design principles for integral cryotank implementation are noted, as are airport requirements and safety and environmental considerations. AIAA

A93-33379
A SYSTEMS APPROACH TO THE DEVELOPMENT OF A FLIGHT TEST PROGRAM FOR AIRCRAFT [SISTEMNYI PODKHOD K FORMIROVANIIU PROGRAMMY LETNYKH ISPYTANII LA]
D. E. GRISHANKOV and N. A. KABANOV *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 15-20. In Russian. refs
Copyright

The problem of the development of an efficient flight test program is separated into three component problems, each of which can be reduced to one of the known mathematical problems. The first problem consists of determining model structures and areas of their efficient application; the second problem consists of determining a set of flight tests required for the parametric identification of the models; the third problem involves the development of the test sequence and determining the required resources. The solution of the third problem is demonstrated for the case of the development of a test program required for the analysis of the stability and controllability characteristics of the TU-154 aircraft. AIAA

N93-22486*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN IMPROVED CAMRAD MODEL FOR AEROELASTIC STABILITY ANALYSIS OF THE XV-15 WITH ADVANCED TECHNOLOGY BLADES
C. W. ACREE, JR. Mar. 1993 56 p
(Contract RTOP 505-59-36)
(NASA-TM-4448; A-92022; NAS 1.15:4448) Avail: CASI HC A04/MF A01

In pursuit of higher performance, the XV-15 Tiltrotor Research Aircraft was modified by the installation of new composite rotor blades. Initial flights with the Advanced Technology Blades (ATB's) revealed excessive rotor control loads that were traced to a dynamic mismatch between the blades and the aircraft control system. The analytical models of both the blades and the mechanical controls were extensively revised for use by the CAMRAD computer program to better predict aeroelastic stability and loads. This report documents the most important revisions and discusses their effects on aeroelastic stability predictions for airplane-mode flight. The ATB's may be flown in several different configurations for research, including changes in blade sweep and tip twist. The effects on stability of 1 deg and 0 deg sweep are illustrated, as are those of twisted and zero-twist tips. This report also discusses the effects of stiffening the rotor control system, which was done by locking out lateral cyclic swashplate motion with shims. Author (revised)

N93-22588*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
JET ENGINE HOT PARTS IR ANALYSIS PROCEDURE (J-EIRP)
JOSEPH F. BAUMEISTER Feb. 1993 20 p
(Contract RTOP 505-62-00)
(NASA-TM-105914; E-7605; NAS 1.15:105914) Avail: CASI HC A03/MF A01

A thermal radiation analysis method called Jet Engine IR Analysis Procedure (J-EIRP) was developed to evaluate jet engine cavity hot parts source radiation. The objectives behind J-EIRP were to achieve the greatest accuracy in model representation and solution, while minimizing computer resources and computational time. The computer programs that comprise J-EIRP were selected on the basis of their performance, accuracy, and flexibility to solve both simple and complex problems. These programs were intended for use on a personal computer, but include the ability to solve large problems on a mainframe or supercomputer. J-EIRP also provides the user with a tool for developing thermal design experience and engineering judgment through analysis experimentation, while using minimal computer resources. A sample jet engine cavity analysis demonstrates the procedure and capabilities within J-EIRP, and is compared to a simplified method for approximating cavity radiation. The goal is to introduce the terminology and solution process used in J-EIRP and to provide insight into the radiation heat transfer principles used in this procedure. Author (revised)

N93-22827*# California Univ., Los Angeles. School of Engineering and Applied Science.
CONTROL DESIGN VARIABLE LINKING FOR OPTIMIZATION OF STRUCTURAL/CONTROL SYSTEMS
IK MIN JIN and LUCIEN A. SCHMIT Washington Feb. 1993 185 p
(Contract NSG-1490; RTOP 505-63-10-02)
(NASA-CR-4493; NAS 1.26:4493) Avail: CASI HC A09/MF A02

A method is presented to integrate the design space of structural/control system optimization problems in the case of linear state feedback control. Conventional structural sizing variables and elements of the feedback gain matrix are both treated as strictly independent design variables in optimization by extending design variable linking concepts to the control gains. Several approximation concepts including new control design variable linking schemes are used to formulate the integrated structural/control optimization problem as a sequence of explicit nonlinear mathematical programming problems. Examples which involve a variety of behavior constraints, including constraints on dynamic stability, damped frequencies, control effort, peak transient displacement, acceleration, and control force limits, are effectively solved by using the method presented. Author (revised)

N93-23047*# North Carolina State Univ., Raleigh.
DYNAMIC RESPONSE CHARACTERISTICS OF TWO TRANSPORT MODELS TESTED IN THE NATIONAL TRANSONIC FACILITY
CLARENCE P. YOUNG, JR. Feb. 1993 34 p
(Contract NCC1-141; RTOP 505-59-85-01)
(NASA-CR-191420; NAS 1.26:191420) Avail: CASI HC A03/MF A01

This paper documents recent experiences with measuring the dynamic response characteristics of a commercial transport and a military transport model during full scale Reynolds number tests in the National Transonic Facility. Both models were limited in angle of attack while testing at full scale Reynolds number and cruise Mach number due to pitch or stall buffet response. Roll buffet (wing buzz) was observed for both models at certain Mach numbers while testing at high Reynolds number. Roll buffet was more severe and more repeatable for the military transport model at cruise Mach number. Miniature strain-gage type accelerometers were used for the first time for obtaining dynamic data as a part of the continuing development of miniature dynamic measurements instrumentation for cryogenic applications. This paper presents the results of vibration measurements obtained for both the commercial

and military transport models and documents the experience gained in the use of miniature strain gage type accelerometers.
Author (revised)

N93-23186*# Princeton Univ., NJ. School of Engineering and Applied Science.
AN ANALYTIC MODELING AND SYSTEM IDENTIFICATION STUDY OF ROTOR/FUSELAGE DYNAMICS AT HOVER
STEVEN W. HONG (United Technologies Research Center, East Hartford, CT.) and H. C. CURTISS, JR. 26 Feb. 1993 21 p Presented at Piloting Vertical Flight Aircraft: A Conference on Flying Qualities and Human Factors, San Francisco, CA, 1993
(Contract NAG2-561)
(NASA-CR-192303; NAS 1.26:192303) Avail: CASI HC A03/MF A01

A combination of analytic modeling and system identification methods have been used to develop an improved dynamic model describing the response of articulated rotor helicopters to control inputs. A high-order linearized model of coupled rotor/body dynamics including flap and lag degrees of freedom and inflow dynamics with literal coefficients is compared to flight test data from single rotor helicopters in the near hover trim condition. The identification problem was formulated using the maximum likelihood function in the time domain. The dynamic model with literal coefficients was used to generate the model states, and the model was parametrized in terms of physical constants of the aircraft rather than the stability derivatives resulting in a significant reduction in the number of quantities to be identified. The likelihood function was optimized using the genetic algorithm approach. This method proved highly effective in producing an estimated model from flight test data which included coupled fuselage/rotor dynamics. Using this approach it has been shown that blade flexibility is a significant contributing factor to the discrepancies between theory and experiment shown in previous studies. Addition of flexible modes, properly incorporating the constraint due to the lag dampers, results in excellent agreement between flight test and theory, especially in the high frequency range. Author

N93-23401# Aeritalia S.p.A., Rome (Italy). Gruppo Aerei Trasporto.
REVIEW OF AERONAUTICAL FATIGUE INVESTIGATION ACTIVITIES DEVELOPED IN AERITALIA-GAT DURING THE PERIOD MAY 1987 - APRIL 1989
A. MINUTO Apr. 1989 9 p Presented at 4th AIFA Meeting, Milan, Italy, 10-11 Apr. 1989
(ETN-93-93702) Avail: CASI HC A02/MF A01

A summary of the main activities of the Aeritalia GAT (Italian acronym for air transport group) in the field of aeronautical fatigue is presented. These include the following: fatigue tests for G222 Cargo door hooks; ATR 42/72 full scale (aircraft, horizontal tail, main landing gear and support, foreward/after entry door plug type, cockpit pressure, and carbon/epoxy pressure dome) tests; the MD-11 full scale winglet assembly fatigue test; and specimen fatigue tests (crack propagation, bonded structures, carbon/epoxy solid laminates, cold working effects on 7050-T73 material).
ESA

N93-23416# Construcciones Aeronauticas S.A., Madrid (Spain).
MD-11: WHEN APPEARANCES DECEIVE [MD-11: CUANDO LAS APARIENCIAS ENGANAN]
JOSE ANTONIO MARTINEZCABEZA 1991 12 p In SPANISH Repr. from Revista de Aeronautica y Astronautica, Jul. - Aug. 1991 p 656-667
(ETN-93-93695) Avail: CASI HC A03/MF A01

A report on the (McDonnell Douglas) MD-11 aircraft is presented. The principle objective of the MD-11 design was to create a more economic aircraft than the DC-10. Spanish aeronautical industry involvement is discussed. The principle characteristics of the MD-11 are given. Interior configurations, the flight cabin system, and the engines and consumption are described. An outline of the MD-12X program is included. ESA

N93-23482# Wright Lab., Wright-Patterson AFB, OH.
WORKSHOP ON TRAJECTORY OPTIMIZATION METHODS AND APPLICATIONS: PRESENTATIONS FROM THE 1992 AIAA ATMOSPHERIC FLIGHT MECHANICS CONFERENCE Final Report, period ending 10 Aug. 1992
HARRY A. KARASOPOULOS and KEVIN J. LANGAN Nov. 1992 111 p
(AD-A259761; WL-TR-92-3112) Avail: CASI HC A06/MF A02

This report is a compilation of presentations from the Workshop on Trajectory Optimization Methods and Applications, at the AIAA Atmospheric Flight Mechanics Conference, Hilton Head, South Carolina, on 10 Aug 1992. GRA

N93-23505 Washington Univ., Seattle.
CFD-BASED APPROXIMATION CONCEPTS FOR AERODYNAMIC DESIGN OPTIMIZATION WITH APPLICATION TO A 2-D SCRAMJET VEHICLE Ph.D. Thesis
PETER DAVID MCQUADE 1992 103 p
Avail: Univ. Microfilms Order No. DA9239471

This dissertation investigates the application of approximation concepts to aerodynamic optimization. Such techniques, which are gaining popularity in structural optimization, offer the potential of providing the accuracy of a high-fidelity 'detailed' analysis model at greatly reduced computational cost. This is because the detailed model is used only to 'fine-tune' an approximate model which is then used in the optimizer. The test problem treated is the design optimization of a 2-D scramjet vehicle flying at Mach 6.0 at 30 km altitude. The objective function is net thrust. The following approximation concepts are used: the Taylor series approximation to wall pressures and inlet plane flow properties; and Haftka's Global-Local Approximation applied to the same variables. The performance of these techniques is compared to that for optimizing using CFD alone. Cost reductions are quantified. It is shown that modifications must be made to the formulation of the approximation concepts as they are used in structural optimization, due to the changing grid geometries required by the CFD solver. All correction factors for the approximation concept are applied not to the CFD grid points, but to a constant, dense, nondimensionalized 'correction point grid', which does not change as the CFD grid changes. It is also shown that, in areas where discontinuous phenomena are not important (such as the scramjet nozzle), the approximation concepts can be successfully used, after this modification is made. Optimizations of the nozzle region show that all the approximation concepts result in a 68 percent reduction in the number of calls to the CFD solver. In regions dominated by shock impingements (such as the forebody/inlet), it is found that approximation concepts applied to point properties cannot be used as they currently are in structural optimization, due to the effects of shock movement during correction factor calculations, and due to artifacts of the CFD solver, such as shock smearing. In fact, even though the CFD and the (uncorrected) approximate models optimize to very nearly the same design, the Taylor series and GLA fail to do so. However, application of the GLA to the integrated objective function (net thrust) with zeroth-order correction factors, is unsuccessful. To lay the groundwork for future investigation, a method of improving the behavior of the point-property GLA in the presence of shock impingements is developed and tested. This involves using 'floating' pre- and post-shock coordinate systems for each wall surface. The result is a dramatic reduction in the erratic behavior of the GLA. This technique may form the basis of a generally-applicable GLA technique for aerodynamic optimization.
Dissert. Abstr.

N93-23943 Institute for Aerospace Research, Ottawa (Ontario). Structures and Materials Lab.
A REVIEW OF DESIGN AND MANUFACTURING METHODOLOGIES FOR STIFFENED COMPOSITE PANELS USED IN AIRCRAFT
F. ELALDI, S. LEE, and R. F. SCOTT *In* National Research Council of Canada, Airframe Materials p 103-125 Jul. 1991
Copyright Avail: Canadian Inst. of Mining, Metallurgy and Petroleum, Xerox Tower 1210, 3400 de Maisonneuve Blvd., Montreal, Canada, H3Z 3B8

Stiffened panels used in aircraft structures typically consist of sheets having stiffeners attached and are designed to provide additional stiffness in the direction of primary loading. Lower weight and improved performance of such panels may be achieved by using composite materials in their construction. Design concepts for such panels are discussed, including buckle resistant and post-buckled designs, stiffener configuration, and stiffener-skin attachment design. Design parameters relevant to aircraft structures are evaluated, including load conditions, design of laminate (number of plies and their orientation), spacing between stiffeners, and allowable strain. Eleven computer codes that can be used in the design and analysis of composite stiffened panels are reviewed. For manufacturing these panels, tooling and fabrication are considered to be critical. Current manufacturing approaches focus on cocuring, where the skin and the siffener are cured together in a single autoclave cure, and secondary bonding, where stiffener and skin are cured separately then bonded together. In a review of these approaches, only compression and shear loadings are addressed since they are considered to be the most critical.
Author (CISTI)

N93-23969# Alenia Aeronautica, Pomigliano D'Arco (Italy). Gruppo Aerei Trasporto.
THE ROLE OF FATIGUE TESTING IN THE DESIGN, DEVELOPMENT, AND CERTIFICATION OF THE ATR 42/72
A. MINUTO, S. SCAFARO, A. LANCIOTTI (Pisa Univ., Italy.), and L. LAZZERI (Pisa Univ., Italy.) 1991 21 p
(ETN-93-93704) Avail: CASI HC A03/MF A01

The main lines of the test programs followed for the certification of the ATR 42/72 commuter aircraft concerning the fatigue design are described. A large number of experiments are discussed. The approach followed in defining the load spectra, the criteria for loading sequence construction, and the necessary approximation (truncation and omission), required to carry out the tests in the most convenient way are described. Some of the main problems encountered in the full scale test are discussed. ESA

N93-24074# Cranfield Inst. of Tech., Bedford (England). Flight Dynamics and Control Group.
A SIMULATION OF THE BOEING B-747 AIRCRAFT
A. P. OLIVA and M. V. COOK Jan. 1992 130 p
(CRANFIELD-AERO-9202; ISBN-1-871564453X; ETN-93-93554)
Avail: CASI HC A07/MF A02; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 OAL, United Kingdom, HC

A computer simulation model of the Boeing B-747 aircraft intended for use as a general purpose tool for research into advanced flight control systems for civil aircraft is described. A previous model was adapted with little change and implemented in the Advanced Continuous Simulation Language (ACSL) for use on an appropriate personal computer. Three distinct computer models of the aircraft were produced: a decoupled linear longitudinal model; a decoupled linear lateral directional model; and a fully coupled nonlinear model. ESA

N93-24108*# Vigyan Research Associates, Inc., Hampton, VA.
ANALYSIS OF A HIGH SPEED CIVIL TRANSPORT CONFIGURATION AT SUBSONIC FLOW CONDITIONS USING A NAVIER-STOKES SOLVER Final Report
VICTOR R. LESSARD Washington Feb. 1993 41 p
(Contract NAS1-18585; RTOP 537-03-22-02)
(NASA-CR-4490; NAS 1.26:4490) Avail: CASI HC A03/MF A01

Computations of three dimensional vortical flows over a generic High Speed Civil Transport (HSCT) configuration with an aspect ratio of 3.04 are performed using a thin-layer Navier-Stokes solver. The HSCT cruise configuration is modeled without leading or trailing edge flap deflections and without engine nacelles. The flow conditions, which correspond to tests done in the NASA Langley 8-Foot Transonic Pressure Tunnel (TPT), are a subsonic Mach number of 0.3 and Reynolds number of 4.4 million for a range-of-attack (-.23 deg to 17.78 deg). The effects of the farfield boundary location with respect to the body are investigated. The boundary layer is assumed turbulent and simulated using an algebraic turbulence model. The key features of the vortices and their interactions are captured. Grid distribution in the vortex regions is critical for predicting the correct induced lift. Computed forces and surface pressures compare reasonably well with the experimental TPT data. Author (revised)

N93-24211 Bristol Univ. (England).
A TWO-DIMENSIONAL SPOILER OF ARBITRARY CHORDWISE POSITION IN A LOW SPEED FLOW Ph.D. Thesis
PAUL G. MYERS 1990 230 p
Avail: Univ. Microfilms Order No. BRDX97389

A study has been carried out at low speeds--with a typical Reynolds Number based on chord of 0.56 x 10(exp 6)--into the static characteristics of a nominally two-dimensional spoiler (to be precise, full span and fitted to a wing with large endplates). The spoiler was of height 0.08c (c being chord), at a selection of chordwise positions and at nominal spoiler deflections of 20 deg and 40 deg. This has helped to clarify the results from two complementary studies, each with a similar spoiler but capable of rapid deployment rates. The current study had the spoiler mounted at one of two chordwise positions: forward (at x/c = 0.15) and mid chord (at x/c = 0.50)--whereas a previous study was for a rear spoiler (at x/c = 0.70). Static and dynamic spoiler characteristics are strongly dependent on configuration--incidence (alpha), spoiler projected height and chordwise position--this set of three having a crucial role in determining whether the flow that separates from the spoiler free edge reattaches forward of the trailing edge or extends into the wake. Only the latter flow allows the spoiler to be fully effective. As regards static results, over the viable incidence range (chosen so that the spoiler is effective) a mid chord spoiler is almost equally effective at all alpha whereas a forward spoiler is most effective at high positive alpha and a rear spoiler is most effective at high negative alpha. Surprisingly, the contribution to lift spoiling from the surface opposite the spoiler is generally greater than that from the surface including the spoiler. A rapidly opening spoiler generates a spoiler starting vortex which may lead to a transient increase in lift when the ultimate quasi-steady change is a decrease. This is known as an adverse effect and is strongly dependent on spoiler chordwise location. The other possible transient feature observed is an overshoot during which the maximum recorded transient decrease in lift is much larger than the quasi-steady decrease. A rapidly closing spoiler causes a surge of higher pressure air to be dispelled in the flow direction and this may cause an adverse effect if the spoiler is located far enough forward. Aerodynamic performance is strongly dependent on the distance, d, from spoiler free edge to trailing edge. With U denoting freestream velocity and T the spoiler opening time, UT/d is a more useful parameter than UT/c in comparing spoilers of different chordwise locations.
Dissert. Abstr.

N93-24481*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
USE OF SYSTEM IDENTIFICATION TECHNIQUES FOR IMPROVING AIRFRAME FINITE ELEMENT MODELS USING TEST DATA Final Report
SATHYA V. HANAGUD, WEIYU ZHOU, JAMES I. CRAIG, and NEIL J. WESTON Mar. 1993 112 p
(Contract NAG1-1007)
(NASA-CR-192699; NAS 1.26:192699; E-16-A22) Avail: CASI HC A06/MF A02

A method for using system identification techniques to improve airframe finite element models using test data was developed and demonstrated. The method uses linear sensitivity matrices to relate changes in selected physical parameters to changes in the total system matrices. The values for these physical parameters were determined using constrained optimization with singular value decomposition. The method was confirmed using both simple and complex finite element models for which pseudo-experimental data was synthesized directly from the finite element model. The method was then applied to a real airframe model which incorporated all of the complexities and details of a large finite element model and for which extensive test data was available. The method was

shown to work, and the differences between the identified model and the measured results were considered satisfactory.
Author (revised)

N93-24535*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN EXPERIMENTAL INVESTIGATION OF SUBSONIC FLOW IN A TWO-DIMENSIONAL U-DUCT (Diskette Supplement)
DARYL J. MONSON and H. LEE SEEGMILLER Jul. 1992 108 p Diskette supplement: IBM compatible 3.5-inch DSDD (Contract RTOP 505-59-53)
(NASA-TM-103931; A-92087; NAS 1.15:103931; NONP-SUPPL-DK-93-159802) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A13

An experimental study of the low speed internal flow in a two-dimensional strongly-curved U-duct was conducted in order to acquire fluid dynamic data suitable for evaluating numerical-flow codes. The measurements include surface oil-flow patterns, static pressure distributions obtained with an electronically scanned pressure system, mean and turbulent velocity profiles acquired with laser-Doppler velocimetry, and surface skin friction measured with a laser interferometer skin friction method. The tests were performed at an average Mach number of 0.1, and at Reynolds numbers (based on channel height) of 1 x 10(exp 5) and 1 x 10(exp 6). A high-aspect-ratio geometry together with sidewall boundary-layer suction panels was employed to minimize wall interference effects and obtain nominally two-dimensional flow data. Data files generated are included on a 3.5-inch low-density diskette. Author (revised)

N93-24591 Ministry of Communications, Ottawa (Ontario).
MICROWAVE-POWERED AIRCRAFT Patent
JOHN F. MARTIN, inventor (to Ministry of Communications), JAMES D. DELAURIER, inventor (to Ministry of Communications), GEORGE W. JULL, inventor (to Ministry of Communications), and ARNE LILLEMARK, inventor (to Ministry of Communications) 28 Jan. 1992 18 p Filed 24 Nov. 1987
(CA-PATENT-1-295-019; INT-PATENT-CLASS-B64C-39/02; CTN-93-60635) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC

A microwave powered aircraft is presented. This patent discusses a method for propelling the aircraft by means of microwave energy received by a rectenna. The rectenna is mounted on the underside of a relatively shallow body attached to the underside of the aircraft. The major dimensions of the body extend horizontally and its periphery is vertically curved so as to reduce turbulence in the airstream over the body during flight. The body is separate from the lifting means of the aircraft and is shaped to avoid generation of lift by the body. The lifting surfaces are comprised of wings located forward of the microwave receiving body, which may in that case serve as means for promoting longitudinal stability of the aircraft. The aircraft includes a fuselage with a movable canard located forward of the lifting surfaces, or conventional tail surfaces of the fuselage, for promoting longitudinal stability. A pylon of symmetrical airfoil cross-section is preferably mounted on the fuselage to support the wings. The pylon includes a flap at its trailing edge to cause a side force to act on the aircraft independently of the bank angle of the aircraft. The control of such a surface in conjunction with the aircraft's other control surfaces can produce turns with relatively small bank angles.
Author (CISTI)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A93-30931# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLIGHT AND WIND-TUNNEL CALIBRATIONS OF A FLUSH AIRDATA SENSOR AT HIGH ANGLES OF ATTACK AND SIDESLIP AND AT SUPERSONIC MACH NUMBERS
TIMOTHY R. MOES, STEPHEN A. WHITMORE (NASA, Flight Research Center, Edwards, CA), and FRANK L. JORDAN, JR. (NASA, Langley Research Center, Hampton, VA) Feb. 1993 31 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Previously announced in STAR as N93-19110 refs
(AIAA PAPER 93-1017) Copyright

A nonintrusive airdata-sensing system was calibrated in flight and wind-tunnel experiments to an angle of attack of 70 deg and to angles of sideslip of +/- 15 deg. Flight-calibration data have also been obtained to Mach 1.2. The sensor, known as the flush airdata sensor, was installed on the nosecap of an F-18 aircraft for flight tests and on a full-scale F-18 forebody for wind-tunnel tests. Flight tests occurred at the NASA Dryden Flight Research Facility, Edwards, California, using the F-18 High Alpha Research Vehicle. Wind-tunnel tests were conducted in the 30- by 60-ft wind tunnel at the NASA LaRC, Hampton, Virginia. The sensor consisted of 23 flush-mounted pressure ports arranged in concentric circles and located within 1.75 in. of the tip of the nosecap. An overdetermined mathematical model was used to relate the pressure measurements to the local airdata quantities. The mathematical model was based on potential flow over a sphere and was empirically adjusted based on flight and wind-tunnel data. For quasi-steady maneuvering, the mathematical model worked well throughout the subsonic, transonic, and low supersonic flight regimes. The model also worked well throughout the angle-of-attack and sideslip regions studied. Author

A93-31649
RECENT DEVELOPMENTS IN AIRBORNE PULSED DOPPLER RADAR
JIE JI and LUNTAI SONG (China Leihua Electronic Technology Research Inst., Neijiang) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 90-93. refs
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Some recent achievements in airborne pulsed Doppler radars in China and elsewhere are described. All waveforms (high, medium, and low pulse repetition frequencies) and operational modes are discussed. Multiple-technique compatibility is examined. Some problems encountered in an all-waveform radar and solutions to them are shown. Two prototypes developed at the China Leihua Electronic Technology Research Institute are introduced. AIAA

A93-31691
PHARUS - THE DESIGN OF AN AIRBORNE POLARIMETRIC C-BAND SAR, RESULTS OF THE DEFINITION STUDY INCLUDING THE SAR TESTBED PHARS
P. SNOEIJ (Delft Univ. of Technology, Netherlands), P. HOOGEBOOM, P. J. KOOMEN (TNO, The Hague, Netherlands), and H. POUWELS (National Aerospace Lab., Amsterdam, Netherlands) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 286-289. refs
Copyright

The Phased Array Universal SAR (PHARUS) project in the Netherlands aims for a polarimetric C-band airborne SAR. The project consists of two phases, a definition phase and a realization phase. The definition phase was finished in 1990 and the design

of PHARUS has just recently been completed. This paper focuses on some results of the definition study including the results obtained up to now from the first testflights of the SAR testbed PHARS.
Author

A93-31692
AIRBORNE MULTI-STRIP MULTI-POLARIZATION SIDE-LOOKING SYNTHETIC APERTURE RADAR SYSTEM (CASSAR) AND ITS APPLICATIONS
YOUTIAN BAI, JIANJUN SONG, and YIMING SHAO (Chinese Academy of Sciences, Inst. of Electronics, Beijing, China) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 290-294.
Copyright

The properties and application scope of SAR are summarized. The major characteristics and performances of the airborne multistrip multipolarization sidelooking synthetic aperture radar system developed by the Institute of Electronics, Chinese Academy of Sciences, are detailed. Applications include geologic survey, flood forecasting and surveillance of the Yellow, Yangtze, and Huaiho Rivers, and survey of soil water content. AIAA

A93-31708
AIRBORNE HIGH RESOLUTION MULTISENSOR SYSTEM
A. B. GSCHWENDTNER (MIT, Lexington, MA) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 359-364. Research supported by USAF and DARPA
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A multisensor system consisting of a forward-looking CO2 laser radar with a pixel registered passive 8-12 micron sensor and a boresighted 85.5 GHz high range resolution millimeter-wave (MMW) radar, along with a down-looking high resolution relative range GaAs laser radar is discussed. The data from these sensors and boresighted video cameras are digitally recorded for post flight analysis. Examples of imagery in the various domains including range, relative range, Doppler, intensity and thermal will be presented along with a description of the various sensors and digital recording system. Author (revised)

A93-31718
SOFTWARE TEST TECHNIQUES FOR AIRBORNE FIRE CONTROL PULSE DOPPLER RADAR
JIQUANG YANG and JIANFENG XU (Nanjing Research Inst. of Electronic Technology, China) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 407-410. refs
Copyright

The steps, purposes, components and methods of the software test in the development of an airborne fire control pulse Doppler radar are described. The radar computer is an asynchronous master-slave computer system. Each slave processor and I/O processor is connected directly to the master processor bus by FIO interface. The master-slave architecture avoids the multiprocessor data conflict because there is no direct data transmission between the slaves. The system software test adopts the top-down method. The test program design should consider: cycle calls of the application tasks, parallel management of multitasks, embedded management of multilevel tasks, data communication between multiprocessors, and system software overhead in every cycle. It is argued that software testability should be considered in every phase of the software life cycle. The evaluation of the software design phase at fixed times is an available 'test'. Full use of computer emulation techniques is a mandatory step in the software test. Computer emulation techniques offer lower cost and a shorter radar development cycle, especially with regard to airborne radar. AIAA

A93-31759
THE ELECTROMAGNETIC SCATTERING CHARACTERISTICS CALCULATION FOR HELICOPTERS
DONGLIN SU, SHANWEI LUE, GOUMING CONG, and BAOFA WANG (Beijing Univ. of Aeronautics and Astronautics, China) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 598-601. refs
Copyright

The paper presents a simple method for calculating a helicopter's scattering characteristics. The analysis is based on the geometric theory of diffraction, uniform geometric theory of diffraction, and physical optics. A proper combination of the helicopter's component cross sections is used to obtain its entire RCS. AIAA

A93-31761
FIXED/ROTARY WINGS CLASSIFICATION/RECOGNITION
GERARD COLLOT (Dassault Electronique, Saint-Cloud, France) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 610-612.
Copyright

Two S-band radars for detecting, recognizing, and identifying unknown signals are presented. The RODEO 2 is a ground radar for very-low-, low-, and medium-altitude surveillance, and the DAV is a helicopter for very-low and low-altitude surveillance. Both radars have data processing adapted to different types of targets and particularly to rotary wings. The recognition between fixed and rotary wings is immediate, and identification of the type of helicopter is given in a very short time with a probability of better than 95 deg. AIAA

A93-32396
AVIONICS SYSTEMS FOR FUTURE HELICOPTERS [AVIONIKSYSTEME FUER ZUKUENFTIGE HUBSCHRAUBER]
RUDOLF SCHRANNER (MBB GmbH, Munich, Germany) *In* International Helicopter Forum, 18th, Bueckeburg, Germany, May 16, 17, 1990, Reports Bueckeburg, Germany International Helicopter Center 1990 p. 199-221. In German. Previously announced in STAR as N91-30139 Research supported by DFHB, Bundesamt fuer Wehrtechnik und Beschaffung, BMVg, and BMFT
Copyright

The boundary conditions for system design are given, e.g., user requirements, technology, and integration aspects such as available mass/volume. The interaction of these categories of requirements are shown. The economical aspect and market competition are prevailing for civil projects. The essential element of design of avionics system is the systematic analysis of user requirements. The external integration conditions, such as environmental requirements, radiation safety and standardization of housings exert an influence on avionics design. The aim of system design is to meet with user analysis function, using available technology and considering integration aspects. When taking these conditions into account, a number of possible systems are defined by combination and suitable integration. Author

A93-32397
PROJECTION-SCREEN ORIENTED COCKPIT WITH NIGHT FLIGHT CAPABILITY IN THE PAH-2 WITH DIGITAL DISPLAY OF NAVIGATION AND TACTICS [NACHTSICHTFAEHIGES BILDSCHIRMORIENTIERTES COCKPIT AM BEISPIEL PAH-2 MIT NAVIGATIONS- UND TAKTIKDARSTELLUNG AUF DIGITALER KARTE]
HORST KISTER and MANFRED VOLLMER (VDO Luftfahrtgeraete Werk Adolf Schindling GmbH, Frankfurt am Main, Germany) *In* International Helicopter Forum, 18th, Bueckeburg, Germany, May 16, 17, 1990, Reports Bueckeburg, Germany International Helicopter Center 1990 p. 243-271. In German.
Copyright

The technical realization of a bus/display system consisting of a display and computers for use in the cockpit of the PAH-2 aircraft is discussed. The projection-screen PAH-2 cockpit is

described, and the display and control system architecture of the bus/display system is examined. The computers used in the system are described along with the digital map display and the multifunction display. AIAA

A93-32829
IR SYSTEMS FOR HELICOPTER PILOTAGE
BRIAN BAUMAN and WILLIAM L. WOLFE (Arizona Univ., Tucson) *In* Infrared technology XVIII; Proceedings of the Meeting, San Diego, CA, July 19-22, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 50-55. Research sponsored by McDonnell Douglas Helicopter Co., U.S. Army, and Honeywell, Inc refs
Copyright

As part of a team headed by the McDonnell Douglas Helicopter company and including the Honeywell Systems and Research Division, we have investigated several advanced real-time viewing systems. The study was predicated upon human factors drivers that lead to specifications for several different types of systems. These include systems with 0.6 mr resolution and 170 x 50, 100 x 50, and 50 x 50 FOVs. Author (revised)

A93-32834
AN AIRBORNE THERMAL IMAGER FOR NAVIGATION AND CUEING ASSISTANCE ON LOW-FLYING MISSIONS WITH SINGLE SEAT AIRCRAFT
TORGNY V. CARLSSON (Ericsson Radar Electronics, AB, Molndal, Sweden) *In* Infrared technology XVIII; Proceedings of the Meeting, San Diego, CA, July 19-22, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 159-168. refs
Copyright

A thermal imager system including several optimization features is described. The imager is designed to give good image quality even under severe scene conditions. The system includes several types of image processing functions. One is the Ground Scene Optimization, supervising the imager's gain and offset values, and presenting proper scene dynamics on the monitor screen. Another function is the Local Dynamic Control system, which optimizes the information content from the scene presented to the operator on the monitor screen. Author

A93-32916* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REVIEW OF THE FOCSI (FIBER OPTIC CONTROL SYSTEM INTEGRATION) PROGRAM
ROBERT BAUMBICK (NASA, Lewis Research Center, Cleveland, OH) *In* Specialty fiber optic systems for mobile platforms; Proceedings of the Meeting, Boston, MA, Sept. 5, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 12-19.
Copyright

A joint NASA/NAVY program, called FOCSI, is reviewed which is aimed at designing optical sensor systems to fit the installation and environmentally test passive optical sensors and electrooptic architectures. These optical sensor systems will be flown on an F18 aircraft to collect data on the operability and maintainability of these systems in a flight environment. The NASA F-18 aircraft will be equipped with a 1773 optical databus to transfer the optical sensor information to the aircraft data collection location. AIAA

A93-32917
A FLUORESCENCE-BASED FIBER OPTIC TEMPERATURE SENSOR FOR AEROSPACE APPLICATIONS
SHELLE D. TILSTRA (Rosemount, Inc., Aerospace Div., Burnsville, MN) *In* Specialty fiber optic systems for mobile platforms; Proceedings of the Meeting, Boston, MA, Sept. 5, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 32-37. refs
Copyright

An optical temperature sensor for aircraft and engine environments is described which is based on the fluorescent time rate of decay (TRD) principle. The TRD technique uses light from a source to excite fluorescence in an optical material. The fluorescent material chosen for the sensor makes it possible to use aerospace quality light sources and detectors and to cover the temperature measurement range of -70 to 350 C. A prototype system using 200 micron fiber and an LED light source is accurate to +/-1 C over the sensor temperature range of -70 to 260 C. The electrooptics and signal processing circuit size is small, fitting on a 3 x 5 in circuit card. AIAA

A93-32919
POWER-BY-LIGHT FLIGHT CONTROL - AN EMI IMMUNE BACKUP
JOHN R. TODD (Douglas Aircraft Co., Long Beach, CA) *In* Specialty fiber optic systems for mobile platforms; Proceedings of the Meeting, Boston, MA, Sept. 5, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 48-53.
Copyright

The benefits and issues associated with power-by-light flight control are addressed, and the status of ongoing work to bring it to reality is discussed. An electrically isolated auxiliary flight control mode based on power-by-light technology is proposed to provide a cost effective, electromagnetic interference (EMI) resistant alternative to the electrical and mechanical backup systems. An EMI immune backup system concept based on the optically powered computer/controller is presented. The system is capable of providing extensive EMI survivability and enhanced mission capability. AIAA

A93-33096 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFRARED LIDAR WINDSHEAR DETECTION FOR COMMERCIAL AIRCRAFT AND THE EDGE TECHNIQUE, A NEW METHOD FOR ATMOSPHERIC WIND MEASUREMENT
RUSSELL TARG (Lockheed Missiles & Space Co., Inc., Palo Alto, CA), ROLAND L. BOWLES (NASA, Langley Research Center, Hampton, VA), C. L. KORB, BRUCE M. GENTRY (NASA, Goddard Space Flight Center, Greenbelt, MD), and DOMINIQUE SOUILHAC (Ecole Nationale Superieure d'Electricite et de Mecanique, Nevers, France) *In* Image understanding for aerospace applications; Proceedings of the Meeting, Munich, Germany, June 13, 14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 144-157. refs
Copyright

The edge technique, a new method for measuring small frequency shifts, is described. The technique allows high-accuracy measurement of atmospheric winds (0.2-1 m/s) with a high vertical resolution (10 m) using currently available technology. With the edge technique, a lidar system can be used to obtain range resolved measurements of the wind in the atmosphere from the ground, aircraft, or spaceborne platforms. The edge technique can be used with different lasers over a broad range of wavelengths. AIAA

N93-23102*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLIGHT EXPERIENCE WITH LIGHTWEIGHT, LOW-POWER MINIATURIZED INSTRUMENTATION SYSTEMS
PHILIP J. HAMORY and JAMES E. MURRAY Washington Mar. 1993 18 p Presented at the AIAA 6th Biennial Flight Test Conference, Hilton Head, SC, 24-26 Aug. 1992 Previously announced in IAA as A93-11280
(Contract RTOP 505-59-54)
(NASA-TM-4463; H-1879; NAS 1.15:4463; AIAA PAPER 92-4111)
Avail: CASI HC A03/MF A01

Engineers at the NASA Dryden Flight Research Facility (NASA-Dryden) have conducted two flight research programs with lightweight, low-power miniaturized instrumentation systems built around commercial data loggers. One program quantified the performance of a radio-controlled model airplane. The other program was a laminar boundary-layer transition experiment on a manned sailplane. NASA-Dryden personnel's flight experience with the miniaturized instrumentation systems used on these two programs is reported. The data loggers, the sensors, and the hardware and software developed to complete the systems are

described. How the systems were used is described and the challenges encountered to make them work are covered. Examples of raw data and derived results are shown as well. Finally, future plans for these systems are discussed. For some flight research applications where miniaturized instrumentation is a requirement, the authors conclude that commercially available data loggers and sensors are viable alternatives. In fact, the data loggers and sensors make it possible to gather research-quality data in a timely and cost-effective manner. Author (revised)

N93-23175*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FIBER-OPTIC INTERFEROMETRIC SENSORS FOR MEASUREMENTS OF PRESSURE FLUCTUATIONS: EXPERIMENTAL EVALUATION
Y. C. CHO and P. T. SODERMAN Jan. 1993 14 p
(Contract RTOP 505-59-54)
(NASA-TM-104002; A-93042; NAS 1.15:104002) Avail: CASI HC A03/MF A01

This paper addresses an anechoic chamber evaluation of a fiber-optic interferometric sensor (fiber-optic microphone), which is being developed at NASA Ames Research Center for measurements of pressure fluctuations in wind tunnels. Author

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A93-29935
EXPERIMENTAL INVESTIGATION ON WHIRL FLUTTER OF PROPELLER ROTOR SYSTEM
ZHIWEI LI, MING XU, and XINGMIN REN (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 37-40. In Chinese. refs

A whirl flutter of a propeller rotor system has been investigated experimentally in a wind tunnel. The experiments show that, if the support stiffness of the propeller rotor system is reduced as a result of failure of some elements in the engine frame or mount, the threshold flight velocity of onset whirl flutter will be decreased. The results of the wind tunnel experiments exhibit the same trends as in theoretical calculations. Author

A93-29937
SUPERSONIC UNSTALLED FLUTTER IN ARBITRARY MISTUNED CASCADES
QINWU LI (National Univ. of Defense Technology, Changsha, China), QUN HEN, and FEIDA FAN (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 45-48. In Chinese. refs

By the use of Hamilton's principle, a set of aeroelastic equation is formulated to describe the motion of an arbitrary mistuned rotating cascade with high aspect-ratio, flexible pretwisted, and nonuniformed blades. A two-dimensional aerodynamic theory is used to calculate the unsteady force and moment coefficients for a vibrating aerofoil in supersonic unstalled cascade. This set of equations is of great value to a fan blade with the inertial, structural, and aerodynamic coupling in bending-bending-torsion. Results obtained from the aeroelastic stability analysis of a real fan stage show that the amplitude and the different order of mistuning and other kinds of structural properties have an apparent effect on boundaries of supersonic unstalled flutter. Author

A93-29941
ON MODELLING CONDITIONS FOR COOLING EFFECTIVENESS EXPERIMENTS
XUGUANG QIU (Beijing Univ. of Aeronautics and Astronautics, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 59-62. In Chinese.

According to strict theory of similarity, the modeling conditions for model experiments on cooling blades or vanes of a gas turbine are obtained from a necessary set of differential equations and single-valued conditions. It is shown that, when the pressure in modeling is lower than that in the actual turbine, the temperature in modeling must be lowered simultaneously in order to maintain the criterion on pl/mu sq rt c(p)T for cooling air and for gas invariant. Therefore, it is necessary to increase the pressure and to decrease appropriately the temperature in modeling tests for the blades and vanes of high-pressure turbines with high pressure ratio. Author

A93-29945
FUEL CONTROL FAILURE RESEARCH FOR JT8D ENGINE
CHUNSHENG XU, ZHILI YU, and QIANCHAO MA (Civil Aviation Inst. of China, Tianjin) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 72-74. In Chinese.

A failure research of the fuel control in JT8D turbofan engine has been completed, which results in effective reduction of its unscheduled removal rate and sets up the foundation for domestic fuel control repairs. The methods of the theoretical analysis, simulation, adjustment tests, and establishing and practicing the diagram of failure insulation are applied to the failure research. Its economic and social benefits are obvious. Author

A93-29947
PRIMARY RATED LIFE ESTIMATION FOR TURBINE DISC
JUN JIA, SHENGGANG LONG, and PINGXUAN TANG (Guizhou Aeroengine Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 83-86. In Chinese. refs

The estimation of the primary rated life is studied for an aeroengine turbine disk. A method for this purpose is considered and put into practice. The rated life of turbine disk is predicted by local stress-strain approach Larson-Miller curve and Masson Linear rule. Then, it is proved by tests. In the life test investigation of the turbine disk, the equivalent accelerated test loading spectrum not only conformed with equivalent rule (without changing dangerous position and damage characteristics) not only accelerates test, but also satisfied life test specifications. Besides, the turbine disk is enclosed in a case hotted up by middle-frequency electroinduction. Author

A93-30833* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECT OF TABS ON THE FLOW AND NOISE FIELD OF AN AXISYMMETRIC JET
M. SAMIMY (Ohio State Univ., Columbus), K. B. M. Q. ZAMAN (NASA, Lewis Research Center, Cleveland, OH), and M. F. REEDER (Ohio State Univ., Columbus) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 609-619. Research supported by Ohio Aerospace Inst refs
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The effect of vortex generators, in the form of small tabs projecting normally into the flow at the nozzle exit, on the characteristics of an axisymmetric jet is investigated experimentally over the jet Mach number range of 0.3-1.81. The tabs eliminate screech noise from supersonic jets and alter the shock structure drastically. They distort the jet cross section and increase the jet spread rate significantly. The distortion produced is essentially the same at subsonic and underexpanded supersonic conditions. Thus, the underlying mechanism must be independent of compressibility effects. A tab with a height as small as 2 percent of the jet diameter, but larger than the efflux boundary-layer thickness, is found to produce a significant effect. Flow visualization reveals that each tab introduces an 'indentation' into the high speed side of the shear layer via the action of streamwise vortices. These

vortices are inferred to be of the 'trailing vortex' type rather than of the 'necklace vortex' type. It is apparent that a substantial pressure differential must exist between the upstream and the downstream sides of the tab to effectively produce these trailing vortices. This explains why the tabs are ineffective in the overexpanded flow, as in that case an adverse pressure gradient exists near the nozzle exit which reduces the pressure differential produced by the tab. Author

A93-30954#
DEVELOPMENT OF A COMPOSITE AIRCRAFT GENERATOR HOUSING WITH IMPROVED THERMAL MANAGEMENT
D. L. VRABLE and F. L. BEAVERS (Sparta, Inc., San Diego, CA) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1050) Copyright

This paper documents a design study of an organic matrix composite housing for an aircraft generator. The primary design issue considered was transfer of the heat dissipated by electronic components mounted on the outside of the generator housing to cooling oil flowing through an annulus on the inside. Incorporation of transversely oriented metal pin fins within the composite structure was shown to significantly improve thermal performance. The pin fins enhance heat transfer through the short transverse direction of the composite, and increase the heat transfer coefficient on the generator housing inner wall. The composite generator housing design was shown to offer lighter weight, improved thermal management and equivalent structural performance to a current aluminum component. Author

A93-30955#
POWER TECHNOLOGY FOR THE MORE ELECTRIC AIRCRAFT
JOSEPH A. WEIMER and LOWELL D. MASSIE (USAF, Wright Lab., Wright-Patterson AFB, OH) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1051)

The Air Force's More Electric Aircraft (MEA) initiative embraces the concept of utilizing electrical power for aircraft functions currently driven by hydraulic, pneumatic or mechanical means including flight control actuation, braking, landing gear, and numerous other utility functions. An important part of this initiative is the development and demonstration of electrical power and power electronic components and systems to enhance reliability, fault-tolerance, power density and performance. This paper describes some of the key electrical power and power electronic technologies being pursued by the Air Force to make the concept of a MEA a reality. The paper describes the results or progress to date of Air Force funded MEA programs such as the High Reliability Generator program, Integral Starter Generator program, and MOS Controlled Thyristor program. Also a brief discussion of future related programs will be included. Integration of advanced MEA technologies will dramatically increase aircraft reliability and reduce susceptibility to battle damage. The needs for aircraft maintenance and support will be reduced along with ground support equipment and maintenance personnel. Author

A93-31096
ANALYSIS OF THE STRESS-STRAIN STATE OF THE LOCKING JOINT COMPONENTS OF THE COMPRESSOR DISK OF A GAS TURBINE ENGINE IN A THREE-DIMENSIONAL ELASTIC FORMULATION. I [ANALIZ NDS ELEMENTOV ZAMKOVOGO SOEDINENIIA DISKA KOMPRESSORA GTD V TREKHMERNOI UPRUGOI POSTANOVKE. I]
V. N. SHLIANNIKOV, B. V. IL'CHENKO, and N. V. STEPANOV Problemy Prochnosti (ISSN 0556-171X) no. 12 1992 p. 15-21. In Russian. refs
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Effects of stress redistribution during the complex loading of a typical dovetail joint are investigated numerically. The effect of the loading type and geometrical parameters on the stress intensity distribution is determined. Elastic stress concentration surfaces are obtained as a function of the nominal stress ratio and the mortise angle. It is shown that consideration of the torque is essential in stress-strain calculations for this type of locking joint. V.L.

A93-31101
GAS DYNAMICS IN JET-ENGINE UNITS AND COMPONENTS [GAZOVAIA DINAMIKA V UZLAKH I ELEMENTAKH VRD]
S. M. SHLIAKHTENKO, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 90 p. In Russian.
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The papers contained in this volume present an overview of recent experimental and theoretical research concerned with gas dynamics in jet engine units and components. Topics discussed include a simple algorithm for smoothing blade profile outlines, a test bench for the gasdynamic studies of the characteristics of birotatory turbine operation, a mathematical model of a compressor with intercooling in the engine system, and analysis of flux structure in the interference region of two intersecting planes. Papers are also presented on a model of supersonic gas-droplet flows with allowance for interphase heat and mass transfer, a detailed kinetic mechanism of methane-air mixture combustion, and estimation of losses in the flow path of axial-flow microturbines. (For individual items see A93-31102 to A93-31118) V.L.

A93-31105
A TEST BENCH FOR THE GASDYNAMIC STUDIES OF THE CHARACTERISTICS OF BIROTATORY TURBINE OPERATION [STEND DLIA GAZODINAMICHESKIKH ISSLEDOVANII OSOBENNOSTEI RABOCHEGO PROTSESSA BIROTATIVNOI TURBINY]
S. D. GRITSAI, O. N. EMIN, and V. I. KUZNETSOV *In* Gas dynamics in jet-engine units and components Moscow *Izdatel'stvo Moskovskogo Aviatsionnogo Instituta* 1991 p. 15-19. In Russian. refs
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The general design and operation of a test bench that is being developed for studying both integral and gasdynamic characteristics of the stages of birotatory turbines are described. Particular attention is given to the study of the structure of gasdynamic flow in the axial gap between the blade cascades. The discussion also covers the problem of determining flow losses and the development of a computer program for determining the characteristics of birotatory turbines in real time during testing. V.L.

A93-31106
AN EXPERIMENTAL STUDY OF THE EFFECT OF THE BLADE RING SPACING AND RADIAL ROOT CLEARANCE OF A SHROUDLESS NOZZLE RING ON THE EFFICIENCY OF A PARTIAL-ADMISSION TURBINE [EKSPERIMENTAL'NOE ISSLEDOVANIE VLIIANIIA MEZHVENECHNOGO RASSTOIANIIA I RADIAL'NOGO KORNEVOGO ZAZORA BEZBANDAZHNOGO SOPLOVOGO APPARATA NA EFFEKTIVNOST' PARTSIAL'NOI TURBINY]
B. A. KRYLOV and A. IU. MEZIN *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 19-23. In Russian.
Copyright

Experimental data are presented on the effect of axial and radial clearances on the efficiency of active partial-admission turbine stages with shroudless blades. It is shown that the effect of the axial clearance on turbine efficiency is only slight but becomes somewhat more pronounced as the radial clearance is increased. The experimental data presented here can be used for estimating the efficiency of low-volume partial-admission turbine drives. V.L.

A93-31107
A MATHEMATICAL MODEL OF A COMPRESSOR WITH INTERCOOLING IN THE ENGINE SYSTEM [MATEMATICHESKAIA MODEL' KOMPRESSORA S PROMEZHUTOCHNYM OKHLAZHDENIEM V SISTEME DVIGATELIA]

V. I. BAKULEV, V. V. KOZLIAKOV, and I. V. KRAVCHENKO *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 24-27. In Russian.

A first-level mathematical model of an intercooled compressor is developed which includes fundamental relations describing processes in plant elements and conditions of their interaction. The principal assumptions of the model and the available options that can be selected in the computational program are briefly reviewed. The model has been implemented in a system of modular programs written in PL. V.L.

A93-31108
EFFECT OF THE CIRCUMFERENTIAL BLADE VELOCITY U(K) OF AN AXIAL-FLOW COMPRESSOR ON THE TOTAL MASS OF A TURBOJET ENGINE AND THE FUEL [O VLIIANII OKRUZHNOI SKOROSTI LOPATOK U/K/ OSEVOGO KOMPRESSORA NA SUMMARNUIU MASSU TRD I TOPLIVA]
O. M. BELKOVA and A. A. LEVIN *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 27-31. In Russian. refs

A system of equations is derived for determining the dependence of the combined mass of a free-turbine turbojet engine and the fuel on the circumferential blade velocity of the axial-flow compressor. As an example, the system of equations is used to calculate the amount of fuel required for the operation of a 2000-kW turbojet engine for 1 and 5 hours for different circumferential blade velocities in the range 280-400 m. In the range investigated, the fuel mass is found to increase substantially with u(k). V.L.

A93-31113
ESTIMATION OF LOSSES IN THE FLOW PATH OF AXIAL-FLOW MICROTURBINES [OTSENKA POTER' V PROTOCHNOI CHASTI OSEVYKH MIKROTURBIN]
B. A. KRYLOV and S. A. GUSAROV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 51-56. In Russian. refs

A method and equipment for the experimental determination of losses in the flow path of axial-flow microturbines are presented. Based on an analysis of experimental data, expressions are obtained for estimating losses in the flow path of microturbines and determining their efficiency at the design stage. A comparison of the maximum efficiency of eight microturbine stages with experimental characteristics of the same stages demonstrates the validity of the approach. V.L.

A93-31115
PRACTICAL APPLICATION OF PLANE EXHAUST NOZZLES [PRAKTICHESKOE ISPOL'ZOVANIE PLOSKIKH VYKHODNYKH USTROISTV]
O. V. BONDAREV *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 63-68. In Russian. refs

Applications of multifunctional plane exhaust nozzles are reviewed with reference to recent data in the literature. In particular, attention is given to tests of plane exhausts on the F-15 STOL aircraft, the STOL/Maneuver Technology Demonstrator program, the ND-102 project, and the EFA and ATF fighter aircraft. Other applications discussed include the F-117A fighter aircraft and the B-2 strategic bomber. V.L.

A93-31117
A STUDY OF FLOW STRUCTURE IN A NONSYMMETRIC SUPERSONIC NOZZLE WITH ALLOWANCE FOR AFTERCOMBUSTION [ISSLEDOVANIE STRUKTURY TECHENIIA V SVERKHZVUKOVOM NESIMMETRICHNOM SOPLE S UCHETOM DOGORANIIA]
D. D. ROMASHKOVA *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 77-82. In Russian. refs

A program for calculating flows in nonsymmetric supersonic nozzles has been developed in order to determine the quantitative effect of chemical nonequilibrium on thrust losses. The program is a combination of an implementation of a stationary analog of Godunov's finite difference scheme and a program for calculating hydrogen combustion in air. The calculation procedure employs the principle of splitting by physical processes. Flow of a gas in a plane nozzle is examined for two chemical compositions of the mixture at the inlet. V.L.

A93-31118
AN EXPERIMENTAL STUDY OF A THRUST-REVERSER MODEL [EKSPERIMENTAL'NOE ISSLEDOVANIE MODELI REVERSIVNOGO USTROISTVA]
V. A. GOLUBEV and A. V. KOTOVICH *In* Gas dynamics in jet-engine units and components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 82-87. In Russian. refs

Results of experiments conducted on a thrust reverser model are reported for total inlet pressures varying from 1.2 x 10 exp 5 to 5.5 x 10 exp 5 Pa. The experimental results demonstrate satisfactory reproducibility of pressure distribution fields at the center body and at the throttling element. V.L.

A93-31130
EXOEMISSION DIAGNOSTICS OF THE SURFACE LAYER OF GAS TURBINE ENGINE COMPONENTS FOLLOWING ION TREATMENT [EKZOEMISSIONNAIA DIAGNOSTIKA POVERKHNOSTNOGO SLOIA DETALEI GTD POSLE IONNOI OBRABOTKI]
M. V. ZVEREV and V. V. SHORIN *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 16-23. In Russian.

The use of photostimulated exoelectron emission for the detection of defects in the surface layer of structural materials is discussed. Attention is given to the fundamental characteristics of exoelectron emission and the principal requirements for the equipment used for measuring the intensity of exoelectron emission. Particular consideration is given to the use of this diagnostic technique for the detection of radiation defects in the surface layers of gas turbine blades following ion alloying. The equipment for the exoelectron emission analysis can be installed directly in the vacuum chamber of the ion-implantation apparatus, which makes this method particularly efficient. V.L.

A93-31131
IMPROVEMENT OF THE ACCELERATION RESPONSE TUNING OF GAS TURBINE ENGINES [SOVERSHENSTVOVANIE OTLADKI PRIEMISTOSTI GTD]
I. M. DEMINA, A. A. ZARIN, and V. I. TSYGANOV *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 23-25. In Russian. refs

Based on statistical data obtained during the tuning of gas turbine engines, a mathematical model is developed which describes the dependence of the acceleration response of the engine as a function of the cold-flow test of the four throttle banks. The analysis indicates that the cold-flow test of only one of the four rotors is a significant factor in response tuning. The resulting formula facilitates the tuning of the engine response. V.L.

A93-31137
PROBLEMS AND DIRECTIONS OF RESEARCH AIMED AT INCREASING THE RELIABILITY OF THE FUEL-CONTROL EQUIPMENT OF GAS TURBINE ENGINES [PROBLEMY I NAPRAVLENIIA ISSLEDOVANII PO POVYSHENIIU NADEZHNOSTI RABOTY TOPLIVOREGULIRUIUSHCHEI APPARATURY GTD]
V. E. LOGINOV and V. I. TONKIKH *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 56-60. In Russian. refs
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The problem of the reliability of the fuel-control equipment of gas turbine engines is defined, and the principal factors responsible for the most frequent faults and failures are identified. In particular, it is noted that one of the most characteristic causes of fuel-control system faults is a change of the surface mating parameters of precision pairs resulting from a degradation of surface properties. Ways of increasing the reliability of precision pairs are summarized. V.L.

A93-31167
RESULTS OF EXPERIMENTAL STUDIES OF A REVERSE-THRUST DEVICE MODEL [REZUL'TATY EKSPERIMENTAL'NYKH ISSLEDOVANII MODELI REVERSIVNOGO USTROISTVA]
V. M. ANDRIENKO, A. A. BUZOV, V. A. GOLUBEV, A. V. KOTOVICH, and N. A. RIABOV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 68-71. In Russian. refs
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The operating characteristics of a reverse-thrust device model are investigated over a wide range of pressure differentials (1.1-5.5). The model proposed here is characterized by a sufficiently high (about 0.88) flow coefficient. Integral pressure losses, which determine the flow coefficient at supercritical pressure differentials, are related mainly to the flow reversal. V.L.

A93-31168
EFFECT OF WATER VAPOR INJECTION ON VIBRATIONAL COMBUSTION IN A MODEL COMBUSTION CHAMBER [VLIIANIE VPRYSKA VODIANOGO PARA NA VIBRATSIONNOE GORENIE V MODEL'NOI KAMERE SGORANIIA]
A. P. BYKOVETS, V. M. LARIONOV, and E. IU. MARCHUKOV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 71-74. In Russian. refs
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The effect of water vapor injection on the limits of vibrational combustion in a model combustion chamber of a gas turbine engine is investigated experimentally. It is shown that the injection of water vapor makes it possible to completely eliminate gas fluctuations in the combustion chamber. The injection of water vapor into the central part of the recirculation zone of the flame stabilizer is found to be particularly effective from the standpoint of ensuring the stability of combustion. V.L.

A93-31169
EFFECT OF THE QUALITY OF FUEL ATOMIZATION ON THE DISCHARGE OF BENZOPYRENE WITH THE EXHAUST GASES OF AVIATION GAS TURBINE ENGINES [O VLIIANII KACHESTVA RASPYLIVANIIA TOPLIVA NA VYBROS BENZ/A/PIRENA S OTRABOTANNYMI GAZAMI AVIATSIONNYKH GTD]
S. V. LUKACHEV and S. G. MATVEEV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 74-76. In Russian. refs
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The quality of fuel atomization is shown to be one of the main factors determining the emission of benzopyrene with the exhaust gases of gas turbine engines. By increasing the dispersity of the atomized fuel by using high-pressure pneumatic spray nozzles, it is possible to reduce the emission of benzopyrene in low-throttle operation by several times. Experimental data are presented for kerosene and diesel fuel. V.L.

A93-31171
EFFICIENCY OF AIR-WATER COOLING WITH WATER INJECTION INTO THE CAVITY OF GAS TURBINE ENGINE BLADES [EFFEKTIVNOST' VOZDUSHNO-VODIANOGO OKHLAZHDENIIA PRI VPRYSKE VODY V POLOST' LOPATKI TURBINY GTD]
A. A. RYZHOV, IU. S. SHATALOV, K. M. ISKAKOV, V. A. TRUSHIN, V. F. SHAIAKBEROV, and A. V. SEREDA Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 79-82. In Russian. refs
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The efficiency of air-water cooling with water injection into the blade cavity and into the evaporator chamber was investigated experimentally using a vortex-type blade under conditions close to the actual operating conditions of gas turbines. It is found that injecting water directly into the blade cavity makes it possible to achieve higher cooling efficiency than in the case of preliminary evaporation of the water in the evaporator chamber. A luminescent inspection of the external surface of the blade following the experiments showed no cracks. V.L.

A93-31174
DETERMINATION OF THE INTERNAL THRUST OF JET ENGINES FROM MEASURED STATIC GAS PRESSURES [OPREDELENIE VNUTRENNEI TIAGI VRD PO IZMERENNYM STATICHESKIM DAVLENIIAM GAZA]
I. G. TSYBALOV and V. N. STEPANENKO Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 88-92. In Russian. refs
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A formula for the thrust of jet engines is derived as a function of static pressure. Static pressures are measured at two sections of the air intake and at two sections of each engine nozzle. Results of experimental studies aimed at the verification of the proposed method for determining the engine thrust are presented. V.L.

A93-31175
EFFECT OF MIXER ADJUSTMENT ON THE HYDRAULIC LOSSES IN THE AFTERBURNER OF A BYPASS ENGINE [VLIIANIE REGULIROVANIIA SMESITELIA NA GIDRAVLICHESKIE POTERI V FORSAZHNOI KAMERE TRDDF]
V. V. MEDVEDEV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 92-95. In Russian. refs
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The effect of mixer adjustment on the hydraulic losses in the diffuser and flame stabilizer of the afterburner of a bypass engine is determined experimentally. A comparison is made of the integral pressure losses in diffusers with ring and lobe mixers at the intake. The importance of considering hydraulic losses in the afterburner when optimizing bypass engine parameters through mixer adjustment is demonstrated. V.L.

A93-31536
TURBOJET-TYPE ENGINES FOR THE AIRBREATHING PROPULSION OF REUSABLE WINGED LAUNCHERS
J. L. DUPARCQ, E. HERMANT (Hyperspace, Suresnes, France), and D. SCHERRER (ONERA, Chatillon, France) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 1 Jan. 1993 p. 41-50. Previously cited in issue 03, p. 281, Accession no. A91-13909 refs
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A93-31784
SPINNING MODE ANALYSIS OF THE ACOUSTIC FIELD GENERATED BY A TURBOSHAFT ENGINE
D. BLACODON and S. LEWY (ONERA, Chatillon, France) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1073-1079. AIAA, Aeroacoustics Conference, 13th, Tallahassee, FL, Oct. 22-24, 1990, AIAA Paper 90-4012. Previously cited in issue 02, p. 145, Accession no. A91-12524 Research supported by Service Technique des Programmes Aeronautiques and Turbomeca refs
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A93-31965* National Aeronautics and Space Administration, Washington, DC.
NUMERICAL MODELING OF WALL-INJECTED SCRAMJET EXPERIMENTS
C. P. BRESCIANINI and R. G. MORGAN (Queensland Univ., Brisbane, Australia) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 169-175. Research supported by Australian Research Council refs
(Contract NAGW-674)
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A wall-injected, hydrogen-fueled scramjet is modeled numerically using a parabolic Navier-Stokes computer code with a k-epsilon turbulence model and finite-rate chemistry. The numerical results are compared to experimental scramjet data taken in a shock tunnel and are found to be in reasonable agreement. Under the conditions studied, the numerical results show that combustion in the scramjet is mainly mixing limited. Author (revised)

A93-31966
SOME GOVERNING PARAMETERS OF PLASMA TORCH IGNITER/FLAMEHOLDER IN A SCRAMJET COMBUSTOR
G. MASUYA, K. KUDOU, A. MURAKAMI, T. KOMURO, K. TANI, T. KANDA, Y. WAKAMATSU, N. CHINZEI (National Aerospace Lab., Kakuda, Japan), M. SAYAMA, K. OHWAKI (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) et al. Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 176-181. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 26th, Orlando, FL, July 16-18, 1990, AIAA Paper 90-2098. Previously cited in issue 18, p. 2829, Accession no. A90-42017 refs
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A93-32167
A SINGLE-STAGE HEAVY-DUTY TURBINE OF A STOICHIOMETRIC BYPASS ENGINE WITH A LOW BYPASS RATIO [ODNOSTUPENCHATAIA VYSOKONAGRUZHENNAIA TURBINA STEKHIOMETRICHESKOGO TRDD MALOI STEPENI DVUKHKONTURNOSTI]
O. N. EMIN and S. L. MKHITARIAN *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 58-62. In Russian. refs
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The paper is concerned with the possibility of implementing a single-shaft bypass engine using a single-stage heavy-duty turbine. In particular, a specially developed computer program is used to carry out calculations for a single-stage heavy-duty turbine for a single-shaft bypass engine with a maximum gas temperature of 2450 K, a thrust of 140 kN, and a bypass ratio of 0.4. The result of the study indicate that the principal conditions for the implementation of such a turbine are increasing the efficiency of the cooling system and developing new refractory alloys. AIAA

A93-32170
CORRELATION OF DYNAMIC PROCESSES IN THE GAS-AIR PATH OF A POWERPLANT AND IN THE MOUNT BRACES OF GAS TURBINE ENGINES DURING BENCH TESTS [KORRELIATSIIA DINAMICHESKIKH PROTSESSOV V GAZOVOZDUSHNOM TRAKTE SILOVOI USTANOVKI I PODKOSAKH KREPLENIIA GTD V STENDOVYKH ISPYTANIIAKH]
V. U. AKSIANOV *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 72-86. In Russian. refs
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The flow structure in the air intake of gas turbine powerplants was investigated experimentally in relation to the dynamic loading of the powerplant mount braces to determine the gasdynamic stability limits and to simulate the failure of the air intake control system. The experiments were carried out on full-scale gasdynamic test benches using gas turbine engines of various classes and air intakes of different lengths. It is found that, in the frequency range investigated, the characteristics of the dynamic loading of the powerplant provide a reliable estimate of the full spectrum of gas-air path perturbations. AIAA

A93-32182
VIBRATIONS, DEFORMATIONS, AND STRENGTH OF FLIGHT VEHICLE ENGINE STRUCTURES [KOLEBANIIA, DEFORMATSII, PROCHNOST' KONSTRUKTSII DVIGATELEI LETATEL'NYKH APPARATOV]
D. V. KHRONIN, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 72 p. In Russian. For individual items see A93-32183 to A93-32195
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The papers contained in this volume focus on various problems in the design, dynamics, and strength of the structures of flight vehicle engines and on the use of mathematical models for the vibration analysis of rotor systems. Topics discussed include calculation of the forced vibrations of delivery rotors with nonlinear elastically damped supports, gas turbine exhausts as a source of low-frequency vibrations in turbodrives, and creep of a thin-walled cylindrical shell reinforced by stiffness ribs. Papers are also presented on the local strength of the structural elements of heat exchangers, effect of the collision angle of sand particles on the wear rate of the compressor blades of a gas turbine engine, and characteristics of the design of composite rotors for flight vehicle engines with allowance for flexible balancing. AIAA

A93-32183
PROBLEMS OF ROTOR CONTACT IN GAS TURBINE ENGINES [NEKOTORYE PROBLEMY KASANIIA ROTOROV V GTD]
D. V. KHRONIN *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 3-9. In Russian.
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The causes of occasional contact between rotating components in modern aircraft engines are examined, as are the possible consequences. A simple general-purpose model of a rotor with contacting components is developed which makes it possible to solve various contact problems. A detailed analysis of the contact characteristics of complex rotor systems of gas turbine engines can be conducted on the basis of linear equations using the initial parameter method and also by the method of decomposition of forced vibration modes in projections onto coordinate planes with an additional support at the point of contact. Methods of avoiding contact and reducing the contact area are discussed. AIAA

A93-32184
CALCULATION OF THE FORCED VIBRATIONS OF THE ROTORS OF DELIVERY SYSTEMS WITH NONLINEAR ELASTICALLY DAMPED SUPPORTS [RASCHET VYNUZHDENNYKH KOLEBANII ROTOROV AGREGATOV PODACHI NA NELINEINYKH UPRUGODEMPFERNYKH OPORAKH]
IU. N. GORDIENKO *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 9-11. In Russian.
Copyright

A program has been developed which makes it possible to calculate the amplitude-frequency and phase-frequency characteristics of the forced vibrations of axisymmetric rotor models. The elastic and damping characteristics of the nonlinear supports are described by piecewise linear characteristics, making it possible to model supports with the stiffness and damping varying in an arbitrary manner with deformation. The program allows for the linear and quadratic dependence of the force characteristics on the rotor speed. The program also makes it possible to consider various combinations of dry and viscous friction. AIAA

A93-32185
GAS TURBINE EXHAUSTS AS A SOURCE OF LOW-FREQUENCY VIBRATIONS IN TURBINE DRIVES [VYKHLOPNYE USTROISTVA GAZOVYKH TURBIN KAK ISTOCHNIK NIZKOCHASTOTNYKH KOLEBANII V TURBOPRIVODAKH]
IU. N. RAGOZIN *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 11-14. In Russian.
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The mechanisms of low-frequency vibration generation in the exhaust pipes of gas turbine engines are examined with reference to the results of an experimental study. It is noted that the low-frequency vibrations can significantly effect the operation of the turbine and must be taken into account in the design of turbine drives. The most reliable method of preventing vibrations in turbines with convergent exhausts is the shielding of the blade-free part of the rotor. AIAA

A93-32189
A FINITE-ELEMENT ANALYSIS OF THE STRESS-STRAIN STATE OF THE BEARING CASES OF GAS TURBINE ENGINES [ISSLEDOVANIIA NAPRIAZHENNO-DEFORMIROVANNOGO SOSTOIANIIA KORPUSOV OPOR GTD S POMOSHCH'IU METODA KONECHNYKH ELEMENTOV]
IU. P. KIRPIKIN, B. V. SHATROV, IU. R. MARTYNENKO, and D. M. OSIPOV *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 30-36. In Russian.
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A computerized strength analysis system has been developed for the finite-element analysis of the stress-strain state of a wide class of thin-walled structures of complex configurations. The analysis allows for various design characteristics and realistic conditions of loading and mounting. The system is used in the interactive mode and makes it possible to analyze large structures, described by finite element models consisting of more than 4,000 triangular elements. Such an analysis can be accomplished with high accuracy within one or two sessions. The use of the system for the stress-strain analysis of gas turbine engine components is described. AIAA

A93-32191
EFFECT OF THE IMPACT ANGLE OF SAND PARTICLES ON THE WEAR RATE OF THE COMPRESSOR BLADES OF A GAS TURBINE ENGINE [VLIIANIE UGLA SOUDARENIIA CHASTITS PESKA NA INTENSIVNOST' IZNASHIVANIIA LOPATOK KOMPRESSORA GTD]
L. F. VOLKOVA *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 42-47. In Russian. refs
Copyright
Experimental data are presented on the erosion wear resistance of steel (EI961) and titanium (VT8) compressor blades. Empirical expressions are obtained which make it possible to determine the wear rate of steel and titanium blades over a wide range of solid particle sizes and angles and velocities of particle impact against the specimen surface. The formulas can be used for predicting the erosion wear of compressor blades of these materials with allowance for service conditions. AIAA

A93-32192
CLEANING EFFECTIVENESS OF DUST SEPARATORS OF GAS TURBINE ENGINES WITH AIR BLEED-OFF [O STEPENI OCHISTKI PYLEZASHCHITNOGO USTROISTVA GTD S OTBOROM VOZDUKHA]
G. B. BEREZIN *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 47-49. In Russian. refs
Copyright
The principle of operation and the cleaning effectiveness of inertial dust separators with peripheral dust removal and with dust removal toward the axis of symmetry of the separator, which are currently used for the protection of the gas turbine engines of helicopters against dust, are examined. The cleaning effectiveness of such separators is described in terms of a decrease in the blade mass loss resulting from the use of the dust separator. The importance of considering air bleed-off in calculating the effectiveness of dust separators of this type is demonstrated. AIAA

A93-32193
CHARACTERISTICS OF THE DESIGN OF COMPOSITE ROTORS FOR FLIGHT VEHICLE ENGINES WITH ALLOWANCE FOR FLEXIBLE BALANCING [OSOBENNOSTI PROEKTIROVANIIA SOSTAVNYKH ROTOROV DLA S UCHETOM GIBKOI TEKHNOLOGII BALANSIROVKI]
A. I. IL'IANKOV and L. G. SHCHAVELEVA *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 49-54. In Russian.
Copyright
Based on results of theoretical studies, recommendations are given concerning the development of composite rotor designs that allow for the variation of possible residual disbalances. A generalized algorithm for selecting the mass correction method and the number and geometry of balancing loads in an individual correction plane is presented. The maximum permissible value of the initial disbalance is calculated by the maximum-minimum method with allowance for the specified fabrication precision. An illustrative example is presented. AIAA

A93-32194
COMPARISON OF MINIATURE POWERPLANTS FOR SMALL-SIZE AIRCRAFT WITH WANKEL AND TWO-CYCLE PISTON ENGINES [SRAVNENIE MALOGABARITNYKH SU DLIA MLA S DVIGATELEM VANKELIA I S DVUKHTAKTNYM PORSHNEVYM DVIGATELEM]
V. P. ZUEV *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 57-61. In Russian.
Copyright
Results of the bench testing of two miniature engines, a 5-cu cm Wankel engine and a two-cycle piston of comparable size, designed for flying aircraft models, are presented for different propellers and fuels. The start-up and external characteristics of the two engines are discussed, as are the test program and test procedures. It is shown, in particular that maximum power is achieved at 17,500 rpm for the two-cycle engine and at 16,500 rpm for the Wankel engine; the power of the two-cycle engine is 21 percent more than that of the Wankel engine. AIAA

A93-32687
MONTE CARLO ANALYSIS OF RELIABILITY OF AIRCRAFT VARIABLE SPEED CONSTANT FREQUENCY (VSCF) ELECTRICAL POWER SYSTEM
XINHUA MU, YANGGUANG YAN, and YUFU YU (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 1-9. In Chinese. refs
Because the failure parameter of the generator of a VSCF electrical power system follows the Gauss distribution, the analytic study of its reliability is difficult to perform using the common analytical method. A reliability model of an aircraft VSCF electrical power system is analyzed here by applying the Monte Carlo method to the reliability index. The degree of importance of each component of the working model is determined. AIAA

A93-32705
SPECIFYING EXHAUST NOZZLE CONTOURS WITH A NEURAL NETWORK
KEVIN W. WHITAKER, RAVI K. PRASANTH, and ROBERT E. MARKIN (Alabama Univ., Tuscaloosa) AIAA Journal (ISSN

0001-1452) vol. 31, no. 2 Feb. 1993 p. 273-277. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992, AIAA Paper 92-3328. Previously cited in issue 20, p. 3480, Accession no. A92-48911 refs
Copyright

A93-33137
KNOWLEDGE-BASED SYSTEM FOR THE PRELIMINARY AERODYNAMIC DESIGN OF AIRCRAFT ENGINE TURBINES
SANJAY GOEL (General Electric Co., Schenectady, NY), DAVE CHERRY, and BRENT GREGORY (GE Aircraft Engines, Evendale, OH) *In* Applications of artificial intelligence 1993: Knowledge-based systems in aerospace and industry; Proceedings of the Meeting, Orlando, FL, Apr. 13-15, 1993 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 160-170. refs
Copyright

Consideration is given to a turbine design optimization system that automates the turbine preliminary design process and simulates designer interactions through the use of knowledge engineering. The optimization system allows the user to make tradeoffs between multiple design objectives. A slightly different tradeoff weight may result in a significantly different turbine configuration. The utility is greater variety of design options available to the user to factor in mechanical and thermal constraints of the design during optimization by suitably constraining or penalizing aerodynamic design parameters. This capability provides a well-constrained domain that ensures that mechanical and thermal constraints remain close to the boundary during optimization. AIAA

N93-22480*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A FULL-SCALE STOVL EJECTOR EXPERIMENT
WENDY S. BARANKIEWICZ Feb. 1993 134 p
(Contract RTOP 505-68-32)
(NASA-TM-106019; E-7433-1; NAS 1.15:106019) Avail: CASI HC A07/MF A02

The design and development of thrust augmenting short take-off and vertical landing (STOVL) ejectors has typically been an iterative process. In this investigation, static performance tests of a full-scale vertical lift ejector were performed at primary flow temperatures up to 1560 R (1100 F). Flow visualization (smoke generators, yarn tufts and paint dots) was used to assess inlet flowfield characteristics, especially around the primary nozzle and end plates. Performance calculations are presented for ambient temperatures close to 480 R (20 F) and 535 R (75 F) which simulate 'seasonal' aircraft operating conditions. Resulting thrust augmentation ratios are presented as functions of nozzle pressure ratio and temperature. Full-scale experimental tests such as this are expensive, and difficult to implement at engine exhaust temperatures. For this reason the utility of using similarity principles -- in particular, the Munk and Prim similarity principle for isentropic flow -- was explored. At different primary temperatures, exit pressure contours are compared for similarity. A nondimensional flow parameter is then shown to eliminate primary nozzle temperature dependence and verify similarity between the hot and cold flow experiments. Under the assumption that an appropriate similarity principle can be established, then properly chosen performance parameters should be similar for both hot flow and cold flow model tests. Author (revised)

N93-22599*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MATHEMATICAL RELATIONSHIP BETWEEN TWO SETS OF LASER ANEMOMETER MEASUREMENTS FOR RESOLVING THE TOTAL VELOCITY VECTOR
ALBERT K. OWEN Mar. 1993 20 p
(Contract DA PROJ. 1L1-61102-AH-45)
(NASA-TM-105986; E-7511; NAS 1.15:105986; AVSCOM-92-C-038) Avail: CASI HC A03/MF A01

The mathematical relations between the measured velocity fields for the same compressor rotor flow field resolved by two fringe type laser anemometers at different observational locations are developed in this report. The relations allow the two sets of velocity measurements to be combined to produce a total velocity vector field for the compressor rotor. This report presents the derivation of the mathematical relations, beginning with the specification of the coordinate systems and the velocity projections in those coordinate systems. The vector projections are then transformed into a common coordinate system. The transformed vector coordinates are then combined to determine the total velocity vector. A numerical example showing the solution procedure is included. Author

N93-22735# Dayton Univ., OH. Research Inst.
COMBUSTION AND HEAT TRANSFER STUDIES UTILIZING ADVANCED DIAGNOSTICS: COMBUSTION DATA SETS Final Report, 11 Sep. 1987 - 30 Sep. 1992
D. R. BALLAL, S. P. HENEGHAN, W. J. SCHMOLL, F. TAKAHASHI, and M. D. VANGSNESS Nov. 1992 183 p
(Contract F33615-87-C-2767)
(AD-A260211; WL-TR-92-2111) Avail: CASI HC A09/MF A02

A long-term goal of the Air Force is to develop near-stoichiometric gas turbine combustors that will burn broad-specification fuels, and have low maintenance and high durability. Towards meeting this goal, this program had two principal objectives: to design and conduct experiments that will establish a fundamental understanding of lean blowout (LBO), swirling flames, kinetically controlled combustion, and turbine blade cooling, and to provide data sets for evaluating and refining computer models of gas turbine combustor. In this final report, we present the Combustion Data Sets that may be used by modelers in the industry and other laboratories for evaluating and refining computer models of gas turbine combustor. These data sets are for three different technical tasks: step combustor task, bluff body combustor task, and swirl combustor task. More exhaustive information is available in the individual papers listed in this report. All the data sets were prepared using Microsoft Excel V.4.0 for IBM PC-Compatible computers and are available on computer diskettes. GRA

N93-23013*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STUDY OF THE CAPACITANCE TECHNIQUE FOR MEASURING HIGH-TEMPERATURE BLADE TIP CLEARANCE ON CERAMIC ROTORS
JOHN P. BARRANGER Mar. 1993 17 p
(Contract RTOP 510-01-50)
(NASA-TM-105978; E-7502; NAS 1.15:105978) Avail: CASI HC A03/MF A01

Higher operating temperatures required for increased engine efficiency can be achieved by using ceramic materials for engine components. Ceramic turbine rotors are subject to the same limitations with regard to gas path efficiency as their superalloy predecessors. In this study, a modified frequency-modulation system is proposed for the measurement of blade tip clearance on ceramic rotors. It is expected to operate up to 1370 C (2500 F), the working temperature of present engines with ceramic turbine rotors. The design of the system addresses two special problems associated with nonmetallic blades: the capacitance is less than that of a metal blade and the effects of temperature may introduce uncertainty with regard to the blade tip material composition. To increase capacitance and stabilize the measurement, a small portion of the rotor is modified by the application of 5-micron-thick platinum films. The platinum surfaces on the probe electrodes and rotor that are exposed to the high-velocity gas stream are coated with an additional 10-micron-thick protective ceramic topcoat. A finite-element method is applied to calculate the capacitance as a function of clearance. Author

N93-23371# Loughborough Univ. of Technology (England). Dept. of Transport Technology.
CONCEPTUAL DESIGN STUDY OF A VARIABLE CYCLE ENGINE FOR A SUPERSONIC BUSINESS JET M.S. Thesis
LUKE BROWN 1992 149 p
(ETN-93-93486) Avail: CASI HC A07/MF A02

The aim of this project was to produce an engine cycle for both subsonic and supersonic flight conditions that could be produced by the variation of bypass ratio. The basic aircraft and flight profiles are defined followed by the initial conditions of the engine. The starting point, the takeoff, subsonic cruise and supersonic cruise engine cycles are studied. For each of these conditions carpet plots are produced for a range of bypass ratios, turbine entry temperatures, and engine pressure ratios. A selection is made of the most suitable engine cycle for the takeoff condition taking into account jet velocity restrictions. A selection is also made of the most suitable engine cycle for the supersonic condition. Their compatibility was then studied. The results indicated that the two engine cycles were compatible and therefore could be produced by the same engine by the variation of the bypass ratio. The effect of the engine cycle selection on the dimensions of the engine are examined and a schematic diagram of the engine layout is produced. Methods of varying the engine cycle are discussed and compared with the results of this study. There are certain aspects of the engine design which are not entirely satisfactory. Methods by which the design might be improved are discussed. ESA

N93-23391# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
NEW APPROACHES FOR A SECOND GENERATION SUPERSONIC TRANSPORT PROPULSION SYSTEM
PASCAL J. SENECHAL 1991 13 p Presented at 2nd International Aerospace Symposium, Tokyo, Japan, Feb. 1991
(DS-1934; ETN-93-93374) Avail: CASI HC A03/MF A01

Views on cruise Mach number, environmental issues, and relevant engine concepts proposed for a second generation SST (Supersonic Transport), from experience in the development, manufacture, and support of supersonic civil powerplants are presented. The flexibility of the variable cycle engine concepts in meeting the major environmental issues is discussed, and a technology acquisition plan is proposed. Confidence in the variability of a second generation SST is concluded from commercial supersonic operations and a demonstrated safety record. However, to meet noise requirements and future NO(x) standards, variable cycle engines and ultra low NO(x) emission combustor, which require a high effort in technology acquisition and will need demonstration before committing to a full scale development, must be developed. It is anticipated that this effort will lead to worldwide international cooperation. ESA

N93-23669# Boeing Defense and Space Group, Seattle, WA.
X RAY COMPUTED TOMOGRAPHY FOR WHOLE SYSTEM EVALUATION (SMALL ENGINES) Interim Report, Jun. 1990 - Feb. 1991
ALAN R. CREWS and RICHARD H. BOSSI 31 May 1992 52 p
(Contract F33615-88-C-5404)
(AD-A259519; WL-TR-91-4109) Avail: CASI HC A04/MF A01

Under a preliminary testing task assignment of the Advanced Development of X-Ray Computed Tomography Application Program, computed tomography (CT) has been studied for its potential as an engineering analysis tool and an in-service nondestructive evaluation method for whole systems such as small jet engines. CT evaluation has been employed on small jet engines demonstrating its viability for assembly verification, dimensional profiles, and foreign object detection without disassembly. CT systems with energies of 400 kV, 2 MV, 2.5 MV, and 9 MV were used in the study. The sensitivity to feature details in complex systems, such as the jet engines, is improved with higher signal to noise for the same inherent resolution. For long metal paths, the highest energy available is preferred, however many of the 2 MV images showed good sensitivity to internal details, and even 400 kV can be usefully employed in some regions of an engine. The quantitative capability of CT to measure the relative x-ray linear attenuation coefficient and position of small volume elements in an object offers the potential to directly calculate the center-of-gravity (CG) of the object from the CT scan data. Results of CT tests on a test phantom indicates that under certain conditions CG calculations can be made for CT data with sensitivity on the order of 0.15 g-cm in aluminum at 3 cm radius. GRA

N93-24002# Gas Turbine Society of Japan, Tokyo.
PROBLEMS ON NUMERICAL ANALYSIS RELATING TO GAS TURBINES
31 Mar. 1992 171 p In JAPANESE
(DE93-753796; ETDE/JP-MF-93753796) Avail: CASI HC A08/MF A02

At the beginning of CFD (Computational Fluid Dynamics) technology, the streamline curvature method was used for design and analysis of the whole system of turbines and compressors. On the contrary, in the cascade flow analysis method, the inviscid cascade analysis based on potentials or Eulerian equations is in a stage of adolescence. The recent three-dimensional viscous flow field analysis including turbulent flow, heat transfer and chemical reaction is in a stage of transfering to maturity. This analysis seems to be a numerical simulation system including flow, heat transfer, chemical reaction and structure strength in the future. In order to construct the design system by the numerical simulation technology, it is necessary for the simulation technology to be improved in stability, accuracy and calculation efficiency, to be established in reliability and to be validated through high-accurate experiments. The paper presents basic problems, application examples, problems to be pointed out and future issues of CFD technology and also refers to peripherally related technology indispensable to development of CFD and subjects and prospects for commercialization. DOE

N93-24176 Carleton Univ., Ottawa (Ontario).
MEASUREMENT AND PREDICTION OF TIP-CLEARANCE EFFECTS IN A LINEAR TURBINE CASCADE Ph.D. Thesis
METIN ILBAY YARAS 1990 402 p
(ISBN-0-315-68826-2) Avail: Univ. Microfilms Order No. DANN68826

Measurements are performed in a stationary linear cascade of turbine blades for a range of clearances varying from 0.0 to 5.5 percent blade chord. The downstream flow field is measured with a seven-hole pressure probe at several axial locations. The results are analyzed both in terms of vorticity and total pressure loss. The former quantity provides insight into several aspects of the leakage flow, including size and strength of the leakage vortex in relation to the tip-clearance size and the bound circulation of the blade; the diffusion rate of the tip-leakage vortex and its interaction with the passage flow. In this context, a simple model of the vortex based on the diffusion of a line vortex is found to be quite accurate. Evaluation of the losses in the downstream measurement planes in relation to the losses measured inside the tip gap help clarify the dominant tip-leakage loss mechanisms. Based on experimental observations, full verification of existing turbomachinery tip-leakage loss prediction schemes is performed. An improved tip-leakage loss model is developed using one of the existing models as the starting point. Following the stationary linear cascade tests, relative tipwall motion is simulated by a moving belt. Three clearance sizes of 1.5, 2.4 and 3.8 percent blade chord are examined. The tip-gap and downstream flow together with blade pressures are measured for several wall speeds. As the relative wall speed is increased, the mass flow rate through the gap is significantly reduced. The dominant mechanism behind this trend is identified. The relative wall motion alters the tip vortex and passage vortex structures substantially. The trends in the blade loading are found to be in agreement with the observed changes in the vortex structures. Based on the experimental results, the tip-vortex and tip-gap flow models are extended to the case of relative tipwall motion. Succeeding the experimental and theoretical work on tip-leakage flow for plain tip geometry, blade tip treatments to reduce tip-leakage losses are tested with stationary and moving tipwall for clearance sizes of 2.4 and 3.7 percent blade chord. Three types of winglets consisting of pressure-side, suction-side and a combination of the two are considered in comparison to the regular blade tip. Losses extracted from measurements downstream of the blades suggest some reduction of tip-leakage losses with the application of winglets.

The possible physical mechanisms by which winglets reduce the losses are discussed on the basis of downstream flow field data and tipwall static pressures. Dissert. Abstr.

N93-24271# Naval Postgraduate School, Monterey, CA.
AIRCRAFT ENGINE RELIABILITY ANALYSIS USING LOWER CONFIDENCE LIMIT ESTIMATE PROCEDURES M.S. Thesis
RICHARD P. BALDWIN 14 Dec. 1992 91 p
(AD-A260386) Avail: CASI HC A05/MF A01

In this thesis, a spreadsheet model was developed to compute the lower confidence limit (LCL) for the reliability of a complex weapon system using a personal computer. The LCL is an estimate of the lowest reliability a system is expected to have at a given point in time with a given level of confidence. The reliability model is based on a Weibull distribution for the system component failure times. The reliability LCL procedures were extensively validated and determined to be quite accurate when the expected number of failures is at least 10. This model is capable of supporting LCL decisions in support of the Component Improvement Program or new weapon system procurement where reliability growth analysis is used as a decision support tool. This procedure also provides program managers and engineers with a method to perform LCL analysis and thereby reduce their dependence on contractor supplied reliability data. GRA

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A93-30374
DESIGN OF AUTOMATIC FLIGHT CONTROL SYSTEM FOR TURNING FLIGHT OF HELICOPTERS
TADASHI SATO (Iwate Univ., Morioka, Japan), HIROBUMI OHTA (Nagoya Univ., Japan), SHOKICHI KANNO (Ichinoseki National College of Technology, Japan), and TATSUO CHUBACHI (Iwate Univ., Morioka, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811) vol. 35, no. 109 Nov. 1992 p. 119-137. refs

This paper is concerned with a flight control system design for the turning flight of helicopters. The longitudinal and lateral dynamics of bare frames of helicopters are almost unstable and/or nonminimum phase, and are known to be difficult to control. The flight controllers are not allowed to use comparatively higher gains because the plants are very difficult to stabilize perfectly. An automatic flight control system for turning flight is designed using the approximate perfect servo, which is effective to the control of nonminimum phase systems. The simulation results showed an extremely accurate control, which will substantiate the effectiveness of the present method. Author

A93-30959#
ROLL CONTROL DESIGN
JAMES W. KELLY (Kelly Engineering, Los Angeles, CA) Feb. 1993 6 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1057) Copyright

This paper presents a method of designing an air vehicle for roll control. The degrees of freedom considered are the aerodynamic, and control system. The aerodynamics is represented by the lateral-directional three degree of freedom. Laplace transformed equations of motion. The control system is added as additional equations with feedbacks proportional to each of the terms in the aerodynamic equations. The equations are arranged in determinant form and solved for the roots. These roots are plotted on the complex plane or root locus. The 'goodness' of the control system is judged by the position of the poles and zeros on the complex plane and the root locus closures. The root locus criteria for best roll control is that the roll control zero exactly cancel the Dutch Roll mode pole, All other degrees of freedom must be stable. Author

A93-31037#
PRACTICAL OPTIMIZATION - DEVELOPMENT OF THE A-12 PRIMARY FLIGHT CONTROL ACTUATION SYSTEM
DENNIS CAIN (HR Textron, Inc., Santa Clarita, CA) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1164) Copyright

Flight-control actuator systems for high performance aircraft must balance requirements for high power, light weight, safety, and fast response. The design of the hydraulic primary flight-control actuators for the A-12 attack aircraft represented the state-of-the-art for this type of equipment and demonstrated the tradeoffs and risks inherent in practical optimization. This paper presents the technical highlights of this system and discusses two areas of the design development process which led to discovery of previously unpublished information on precipitation-hardened corrosion resistant steels and an innovative technique for achieving lower quiescient hydraulic power losses while retaining dynamic response. Author

A93-31040#
REDUNDANCY MANAGEMENT CONCEPTS FOR ADVANCED ACTUATION SYSTEMS
K. W. VIETEN (Northrop Corp., Pico Rivera, CA), J. D. SNYDER, and R. P. CLARK (General Electric Co., Aircraft Control Systems Dept., Binghamton, NY) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1168) Copyright

The paper describes the concepts and processes that are involved in the design, integration, and validation a fly-by-wire (FBW) direct drive valve (DDV) actuator system. Particular attention is given to the electronic flight control systems' redundancy requirements, the digital vehicle management and actuator architectures, the preflight and in-flight built-in-test, the system implementation, and validation testing. I.S.

A93-31041#
FLIGHT DEMONSTRATION, EVALUATION, AND PROPOSED APPLICATIONS FOR ALL ELECTRIC FLIGHT CONTROL ACTUATION CONCEPTS
R. E. ALDEN (Lockheed Aeronautical Systems Co., Marietta, GA) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1171) Copyright

The paper describes the activities of the Reliability and Maintainability Technology Insertion Program and the Technology Application Program Management project, the first of which comprises the development and flight evaluation of the power-by-wire actuation systems for the aileron and spoiler control systems on C-141 aircraft, and the second comprises the flight evaluation of an electrohydrostatic actuator subsystem in the aileron control system of the C-130 High-Technology Test Bed. Special attention is given to the types and characteristics of the electric actuation concepts which have been and are being evaluated on the C-145 and the C-130. The five areas identified where the benefits of the insertion of power-by-wire actuation technology will support solutions to frequently expressed user needs include the overall aircraft efficiency, reliability and maintainability, survivability, design implications, and operations. I.S.

A93-31042#
SIMULATION APPLICATION TO VEHICLE MANAGEMENT DESIGN
KEIGH L. DAVIS (USAF, Wright-Patterson AFB, OH) Feb. 1993 7 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1172)

The paper discusses the salient features of various types of simulations used throughout the vehicle management development, including manned, unmanned, no-motion, limited and/or six-degrees-of-freedom, and in-flight simulations. Six-degrees-of-freedom simulations, which include flying quality, hardware-in-the-loop, iron bird, and specialty simulations, require a full set of aerodynamic parameters in all six degrees of freedom and a mathematical model for each relevant system. Block diagrams are presented classifying different categories and subcategories of simulations. I.S.

A93-31059#
FLYING QUALITIES CRITERIA FOR ADVERSE WEATHER
DARRELL E. GILLETTE, MARK A. PAGE, and JOHN HODGKINSON (McDonnell Douglas Aerospace, Long Beach, CA) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1191) Copyright

A new approach to establishing aircraft handling qualities criteria in the presence of adverse weather is proposed. This approach, based on the Cooper-Harper rating scale, is both numeric and systematic. It formally accounts for the influence of adverse weather in the absence of mechanical failures, a safety state which is not yet explicitly addressed in most safety analysis criteria. Since adverse weather is a factor in a large percentage of aircraft accidents, designing aircraft to have good handling qualities despite adverse weather conditions may be a high-leverage means of improving overa11 flight safety. Author

A93-31211
REPRESENTATION OF FUNCTIONS FOR THE SYNTHESIS OF MECHANISMS USED IN AIRCRAFT CONTROL SYSTEMS [PREDSTAVLENIE FUNKTSII DLIA SINTEZA MEKHANIZMOV, PRIMENIAEMYKH V SISTEMAKH UPRAVLENIIA SAMOLETOM]
T. I. SOF'INA and N. G. BELIAKOVA *In* Current problems in the dynamics and design of mechanisms and machines Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 43-50. In Russian.
Copyright

The problem of the reproduction of a specified function is considered in connection with the synthesis of mechanisms used in aircraft control systems, and an approach to the solution of the problem is presented. Based on the method proposed here, determinations are made of specified position functions reproducing linear, sinusoidal, tangential, and quadratic functional dependences, which are commonly used in the design of transmission gears. V.L.

A93-31950
PASSIVE CONTROL OF DELTA WING ROCK
COSTAS E. SYNOLAKIS, BRETT D. BREUEL, MURALI TEGULAPALLE, and CHIH-MING HO (Southern California Univ., Los Angeles, CA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 131-133. Research supported by NSF refs
Copyright

The paper reports preliminary laboratory results on passive control of delta wing rock obtained by adding extended winglets near the wing leading edge. The results indicate that the critical angle of attack at which the wing rock occurs is highly dependent on the particular geometric configuration; modified delta wings appear to exhibit behavior similar to that of unmodified wings, and they are dominated by either vortex asymmetry or vortex burst. Extended winglets with a winglet-length to chord-length ratio of 0.43 appear to increase the envelope of operation of the wing substantially in the small apex half-angle region where wing rock occurs. AIAA

A93-31986
CONTROL OF WING-ROCK MOTION OF SLENDER DELTA WINGS
JIA LUO and C. E. LAN (Kansas Univ., Lawrence) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 16, no. 2 Mar.-Apr. 1993 p. 225-231. AIAA Atmospheric Flight Mechanics Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers, p. 373-384. Previously cited in issue 20, p. 3414, Accession no. A91-47185 Research supported by Univ. of Kansas refs
Copyright

A93-31988
ROBUST FLIGHT-PATH CONTROL SYSTEM DESIGN WITH MULTIPLE-DELAY MODEL APPROACH
YOSHIKAZU MIYAZAWA (National Aerospace Lab., Chofu, Japan) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 16, no. 2 Mar.-Apr. 1993 p. 241-246. AIAA Guidance, Navigation and Control Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers. Vol. 1, p. 642-652. Previously cited in issue 21, p. 3599, Accession no. A91-49642 refs
Copyright

A93-31989
REFINED H-INFINITY-OPTIMAL APPROACH TO ROTORCRAFT FLIGHT CONTROL
JIEH-SHIAN YOUNG (Chung Shan Inst. of Science and Technology, Taoyuan, Taiwan) and CHIN E. LIN (National Cheng Kung Univ., Tainan, Taiwan) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 16, no. 2 Mar.-Apr. 1993 p. 247-255. 1992 American Control Conference, 11th, Chicago, IL, June 24-26, 1992, Proceedings. Vol. 2, p. 1523-1528. Previously cited in issue 07, p. 1087, Accession no. A93-22882 refs
(Contract NSC-80-0404-E006-05)
Copyright

A93-32394
ANTITORQUE SYSTEMS OF HELICOPTERS
SIEGFRIED WAGNER (Muenchen, Univ. der Bundeswehr, Munich, Germany) *In* International Helicopter Forum, 18th, Bueckeburg, Germany, May 16, 17, 1990, Reports Bueckeburg, Germany International Helicopter Center 1990 p. 83-127. refs
Copyright

Yaw control in helicopter rotors driven by shafts is surveyed. The configurations addressed include (1) the conventional tail rotor with advanced design solution, (2) the fenestron, and (3) the no-tail rotor concept. The performances of these three design concepts are described, and future trends and possible design variations are examined. AIAA

A93-32699
APPLICATION OF INTEGRATED SIMULATION TECHNIQUE IN FLIGHT MANAGEMENT SYSTEM
JIMEI LIU and TANLIAO ZHENG (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 124-130. In Chinese. refs

The basic structure and functions of the recently developed FMS integrated simulation software are introduced in this paper. Taking lateral guidance of flight management system as an example, problems of implementation and application of the integrated simulation method are explored. It is proved in practice that to study the flight management system with integrated simulation method is very flexible, convenient, and closer to the working condition of a practical system. Author (revised)

A93-32700* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HELICOPTER TRIM ANALYSIS BY SHOOTING AND FINITE ELEMENT METHODS WITH OPTIMALLY DAMPED NEWTON ITERATIONS
N. S. ACHAR and G. H. GAONKAR (Florida Atlantic Univ., Boca Raton) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 225-234. refs
(Contract DAAL03-87-K-0037; DAAL03-91-G-0007; NAG2-727)
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Helicopter trim settings of periodic initial state and control inputs are investigated for convergence of Newton iteration in

computing the settings sequentially and in parallel. The trim analysis uses a shooting method and a weak version of two temporal finite element methods with displacement formulation and with mixed formulation of displacements and momenta. These three methods broadly represent two main approaches of trim analysis: adaptation of initial-value and finite element boundary-value codes to periodic boundary conditions, particularly for unstable and marginally stable systems. In each method, both the sequential and in-parallel schemes are used, and the resulting nonlinear algebraic equations are solved by damped Newton iteration with an optimally selected damping parameter. The impact of damped Newton iteration, including earlier-observed divergence problems in trim analysis, is demonstrated by the maximum condition number of the Jacobian matrices of the iterative scheme and by virtual elimination of divergence. The advantages of the in-parallel scheme over the conventional sequential scheme are also demonstrated. Author

A93-33328
DETERMINATION OF THE BALANCE LIFT-DRAG RATIO OF AIRCRAFT [K VOPROSU OPREDELENIIA BALANSIROVOCHNOGO AERODINAMICHESKOGO KACHESTVA SAMOLETA]
A. I. MATVEEV *In* Problems in the aerodynamics of flight vehicles and their components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 11-18. In Russian. refs
Copyright

A method is proposed for determining the lift-drag ratio of aircraft with allowance for the deflection of the longitudinal balance controls. Expressions are obtained for calculating the balance lift-drag ratio for subsonic and supersonic flight velocities. Satisfactory agreement between the calculated and experimental results is obtained for aircraft models of three different aerodynamic schemes and for different deflection angles of longitudinal balance controls. The method proposed here can be also used in the optimization of the geometrical parameters and deflection angles of longitudinal balance controls as well as the longitudinal static stability margin at subsonic and supersonic velocities. AIAA

A93-33376
ANALYSIS AND SYNTHESIS OF COMPLEX DYNAMIC SYSTEMS [ANALIZ I SINTEZ SLOZHNYKH DINAMICHESKIKH SISTEM]
M. N. KRASIL'SHCHIKOV, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 87 p. In Russian. For individual items see A93-33377 to A93-33391
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The papers presented in this volume focus on problems related to the stability and controllability of flight vehicles, synthesis of algorithms for stability and controllability augmentation systems, aircraft-pilot system, formulation of flight vehicle control laws, and determination of the aerodynamic characteristics of aircraft. Attention is also given to the problem of the optimal planning of flight vehicle tests, characteristics of an elastic aerostatic flight vehicle, and aircraft motion in a turbulent atmosphere. AIAA

A93-33378
A STUDY OF THE STABILITY OF THE PROPER YAWING MOTION IN VARYING-VELOCITY FLIGHT [ISSLEDOVANIE USTOICHIVOSTI SOBSTVENNOGO DVIZHENIIA RYSKANIIA V NEUSTANOVIVSHEMSIA PO SKOROSTI POLETE]
L. I. VYSKREBENTSEV and D. G. MIRONENKO *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 9-14. In Russian. refs
Copyright

The stability of the proper yawing motion of an aircraft under conditions of varying-velocity flight is investigated using the concept of system stability over a finite time period, formulated by Karacharov and Puliutik (1962). The sufficient condition of stability is formulated as a set of conditions guaranteeing that all the functions of solution obtained decrease or, at least, do not increase with time. Specific stability conditions are determined. AIAA

A93-33380
AN ALGORITHM SYNTHESIS METHOD FOR THE LATERAL STABILITY AND CONTROLLABILITY AUGMENTATION SYSTEM OF AIRCRAFT [METOD SINTEZA ALGORITMOV SISTEMY ULUCHSHENIIA USTOICHIVOSTI I UPRAVLIAEMOSTI BOKOVOGO DVIZHENIIA SAMOLETA]
IU. P. GUS'KOV *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 20-28. In Russian. refs
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An approach to the augmentation of the lateral motion stability and controllability of aircraft is proposed which is based on the representation of equations of motion in semibound coordinates. New control parameters are introduced and defined. Procedures for the synthesis of isolated bank and yaw channels are described. AIAA

A93-33381
A METHOD FOR THE EXPERIMENTAL INVESTIGATION OF THE POSSIBILITY OF OCCURRENCE OF PILOT-INDUCED OSCILLATIONS OF A FLIGHT VEHICLE [METODIKA EKSPERIMENTAL'NYKH ISSLEDOVANII VOZMOZHNOSTI VOZNIKNOVENIIA KOLEBANII LETATEL'NOGO APPARATA, INDUTSIRUEMYKH LETCHIKOM]
A. V. EFREMOV, A. V. OGLOBLIN, and A. V. KOSHELENKO *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 28-33. In Russian.
Copyright

Based on an analysis of the results of experimental studies of the aircraft-pilot system in problems of stabilization of the phase coordinates of flight vehicles, a method is proposed for investigating the pilot-induced oscillation (PIO) phenomenon using flight simulators and flying laboratories. The conditions maximizing the probability of PIO are defined, and a command signal is formulated which is capable of generating PIO in experimental investigations of this phenomenon. The method proposed here is illustrated by using the Space Shuttle as an example. AIAA

A93-33382
THE EKRANOPLANE AS THE CONTROLLED PLANT IN AUTOMATIC CONTROL SYSTEMS [EKRANOPLAN KAK OB'EKT UPRAVLENIIA V SAU]
A. M. MAKIENKO *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 33-39. In Russian. refs
Copyright

The longitudinal perturbed motion of the ekranoplane is described by a system of dimensionless operator equations. Due to the presence of multiple-circuit relations between the ekranoplane motion channels, the use of the directional graph method is recommended for the structural analysis of the stabilization circuit and generation of the corresponding transfer functions. The main and auxiliary graphs for the longitudinal motion of the ekranoplane are constructed, and the structure of the flight stabilization circuit for longitudinal motion is derived. AIAA

A93-33383
CONSIDERATION OF NONLINEARITIES IN THE AUTOMATIC CONTROL SYSTEM IN OPTIMIZING THE AERODYNAMIC CONFIGURATION PARAMETERS OF AIRCRAFT [UCHET NALICHIIA NELINEINOSTEI V SAU PRI OPTIMIZATSII PARAMETROV AERODINAMICHESKOI KOMPONOVKI SAMOLETA]
IU. I. MAL'TSEV *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 39-43. In Russian. refs
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An algorithm for considering the nonlinearity of an automatic control system when optimizing the aerodynamic stability of an

aircraft is examined. The algorithm is based on the well-known method of multipliers, which is more computationally efficient than the harmonic linearization method. The principal features of the method are discussed. It is shown that the approach proposed here makes it possible not only to optimize the parameters of an aerodynamic configuration for a specified nonlinearity but also to formulate requirements of the nonlinear element in the automatic control system for the selected configuration parameters. AIAA

A93-33384
A STUDY OF THE CHARACTERISTICS OF AN AEROSTATIC AIRCRAFT AS A SYSTEM OF ELASTIC AND RIGID BODIES [ISSLEDOVANIE KHARAKTERISTIK AEROSTATICHESKOGO LETATEL'NOGO APPARATA KAK SISTEMY UPRUGIKH I TVERDYKH TEL]
N. N. MARKIN *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 43-48. In Russian. refs
Copyright

A combination aerostatic aircraft is treated as a complex mechanical structure with components consisting of elastic and rigid bodies. The problem considered here is that of determining the vibration frequencies and deformations. A hypothetical aerostatic aircraft with rotatable propeller engines enclosed in a ring is examined as an example. The discussion covers components of the mathematical model of the aerostatic aircraft, a model of wind effects, dynamics of internal gas masses, and modeling and analysis of results. AIAA

A93-33385
OPTIMAL INPUT SIGNALS AND OUTPUT CONTROL FUNCTIONS FOR THE IDENTIFICATION OF LINEAR STATIONARY MODELS OF THE LONGITUDINAL AND LATERAL MOTIONS OF AIRCRAFT [OPTIMAL'NYE VKHODNYE SIGNALY I FUNKTSII UPRAVLENIIA VYKHODAMI DLIA IDENTIFIKATSII LINEINYKH STATSIONARNYKH MODELEI PRODOL'NOGO I BOKOVOGO DVIZHENIIA SAMOLETOV]
V. N. OVCHARENKO and V. P. BELIAEV *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 49-55. In Russian. refs
Copyright

The problem of developing an optimal experimental design for plant identification in order to identify the unknown parameters with maximum accuracy and reliability within minimum time is formulated. The problem is solved by using algorithms for selecting the optimal input signals and output control functions of dynamic systems modeling the perturbed motion of aircraft. In the general case, the optimal control laws and output control functions are determined numerically using an iteration scheme. Efficient algorithms for this purpose have been developed and implemented in a set of software written in FORTRAN. Results of control optimization for the identification of the longitudinal motion parameters of a flying laboratory are examined as an example. AIAA

A93-33386
A CONTROL LAW FOR AIRCRAFT TURNS [ZAKON UPRAVLENIIA RAZVOROTOM SAMOLETA]
K. A. PAVLOV and I. A. KIRDAN' *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 55-60. In Russian. refs
Copyright

The paper is concerned with the formulation of a near-optimal control law for aircraft turns for implementation on an airborne digital computer. The control law developed here is based on an analysis of minimum-time turn trajectories. Some optimal turn trajectories based on the law proposed here are presented and compared with those based on the optimal control law. AIAA

A93-33387
EQUATIONS OF AIRCRAFT MOTION IN A PERTURBED ATMOSPHERE [K VOPROSU OB URAVNENIIAKH DVIZHENIIA SAMOLETA V NESPOKOINOI ATMOSFERE]
S. A. PISAREVSKII *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 60-64. In Russian. refs
Copyright

The flight of aircraft in a perturbed atmosphere is analyzed using approximate equations of motion in which the air velocity vector is determined in the same way as for no-wind conditions, and the velocity relative to the ground is represented as a sum of air velocity and wind velocity. This approach is valid for a constant-velocity wind but leads to an error when the wind velocity varies. An analysis of the magnitude of this error is presented. AIAA

A93-33388
GENERATION OF PERTURBATION SIGNALS IN THE PROBLEM OF ACTIVE IDENTIFICATION OF THE PARAMETERS OF LINEAR MATHEMATICAL MODELS OF AIRCRAFT MOTION [FORMIROVANIE VOZMUSHCHAIUSHCHIKH SIGNALOV V ZADACHE AKTIVNOI IDENTIFIKATSII PARAMETROV LINEINYKH MATEMATICHESKIKH MODELEI DVIZHENIIA LA]
B. K. POPLAVSKII and G. N. SIROTKIN *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 64-70. In Russian. refs
Copyright

A method is proposed for generating optimal perturbation signals sent to the controls when solving the problem of determining the coefficients of linear mathematical models of aircraft motion. In contrast to the known methods, which use the a priori values of mathematical model parameters, the method proposed here is based on the determination of an optimal linear combination of typical input test signals and responses generated during a test flight. The coefficients of the linear combination of typical signals are determined on the basis of an adopted optimality criterion. AIAA

A93-33390
A METHOD FOR DETERMINING THE FUNCTIONAL DEPENDENCES OF THE AERODYNAMIC CHARACTERISTICS OF AIRCRAFT FROM FLIGHT TEST RESULTS [METODIKA OPREDELENIIA FUNKTSIONAL'NYKH ZAVISIMOSTEI AERODINAMICHESKIKH KHARAKTERISTIK SAMOLETA PO REZUL'TATAM LETNYKH ISPYTANII]
A. V. CHERNYSHEV *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Mokovskogo Aviatsionnogo Instituta 1991 p. 73-79. In Russian. refs
Copyright

The problem of determining the aerodynamic characteristics of aircraft from flight test results is formulated as that of reconstructing the function A(Y) from experimental data over the entire region of all the permissible values of the vector argument Y. A three-step procedure for determining the functional dependences of the aerodynamic characteristics of aircraft is presented. The method proposed here is illustrated by considering the problem of reconstructing the dependence of the lift coefficient on the angle of attack from quasi-experimental data obtained by the mathematical modeling of the perturbed longitudinal motion of an aircraft during a gliding descent. AIAA

A93-33391
OPTIMALITY OF THE LINEAR CONTROL OF TRAJECTORY MOTION [OB OPTIMAL'NOSTI LINEINOGO UPRAVLENIIA TRAEKTORNYM DVIZHENIEM]
I. M. SHARONOVA *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 79-83. In Russian. refs
Copyright

In an earlier study (Pavlov and Sharonova, 1989), an algorithm was proposed for the synthesis of a linear law for trajectory motion

control. Here, the applicability region of this law is illustrated by two examples. It is demonstrated that the linear control of trajectory motion is sufficiently close to optimal control over a wide range of altitudes. AIAA

N93-22368*# McDonnell Aircraft Co., Saint Louis, MO.
A NEURAL BASED INTELLIGENT FLIGHT CONTROL SYSTEM FOR THE NASA F-15 FLIGHT RESEARCH AIRCRAFT
JAMES M. URNES, STEPHEN E. HOY, ROBERT N. LADAGE, and JAMES STEWART *In* NASA. Johnson Space Center, Proceedings of the Third International Workshop on Neural Networks and Fuzzy Logic, Volume 1 p 109-112 Jan. 1993
Prepared for NASA. Dryden Flight Research Facility, Edwards, CA
Avail: CASI HC A01/MF A03

A flight control concept that can identify aircraft stability properties and continually optimize the aircraft flying qualities has been developed by McDonnell Aircraft Company under a contract with the NASA-Dryden Flight Research Facility. This flight concept, termed the Intelligent Flight Control System, utilizes Neural Network technology to identify the host aircraft stability and control properties during flight, and use this information to design on-line the control system feedback gains to provide continuous optimum flight response. This self-repairing capability can provide high performance flight maneuvering response throughout large flight envelopes, such as needed for the National Aerospace Plane. Moreover, achieving this response early in the vehicle's development schedule will save cost. Derived from text

N93-22369*# Army Aviation Systems Command, Hampton, VA. Aerostructures Directorate.
A TELEOPERATED UNMANNED ROTORCRAFT FLIGHT TEST TECHNIQUE
GREGORY W. WALKER, ARTHUR E. PHELPS, III, and W. TODD HODGES *In* NASA. Johnson Space Center, Proceedings of the Third International Workshop on Neural Networks and Fuzzy Logic, Volume 1 p 113-126 Jan. 1993
Avail: CASI HC A03/MF A03

NASA and the U.S. Army are jointly developing a teleoperated unmanned rotorcraft research platform at the National Aeronautics and Space Administration (NASA) Langley Research Center. This effort is intended to provide the rotorcraft research community an intermediate step between wind tunnel rotorcraft studies and full scale flight testing. The research vehicle is scaled such that it can be operated in the NASA Langley 14- by 22-Foot Subsonic Tunnel or be flown freely at an outside test range. This paper briefly describes the system's requirements and the techniques used to marry the various technologies present in the system to meet these requirements. The paper also discusses the status of the development effort. Author

N93-22575*# Princeton Univ., NJ.
DYNAMIC RESPONSE AND CONTROL OF A JET-TRANSPORT AIRCRAFT ENCOUNTERING A SINGLE-AXIS VORTEX
DARIN R. SPILMAN *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1991-1992 p 141-150 Feb. 1993
Avail: CASI HC A02/MF A02

The dynamic responses of a jet-transport aircraft to two types of single-axis wind vortex encounters are studied. Aircraft attitude, flight path angle, and aerodynamic angle excursions are analyzed and dominating dynamic forcing effects are identified for each encounter. A simple departure-preventing LQR controller is designed to demonstrate the benefits of using automatic control to reduce the wind vortex hazard. A Proportional-Integral-Filter controller structure successfully regulates the critical parameters, roll angle, phi, and sideslip angle, beta, for the two different vortex encounters considered in this study. Author

N93-22576*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
INTELLIGENT FLIGHT CONTROL SYSTEMS
ROBERT F. STENGEL *In* NASA. Langley Research Center, Joint University Program for Air Transportation Research, 1992-1992 p 151-172 Feb. 1993 Presented at the Aerospace Vehicle Dynamics and Control, Bedford, England, 7-10 Sep. 1992
(Contract NGL-31-001-252; DAAL03-89-K-0092)
Avail: CASI HC A03/MF A02

The capabilities of flight control systems can be enhanced by designing them to emulate functions of natural intelligence. Intelligent control functions fall in three categories. Declarative actions involve decision-making, providing models for system monitoring, goal planning, and system/scenario identification. Procedural actions concern skilled behavior and have parallels in guidance, navigation, and adaptation. Reflexive actions are spontaneous, inner-loop responses for control and estimation. Intelligent flight control systems learn knowledge of the aircraft and its mission and adapt to changes in the flight environment. Cognitive models form an efficient basis for integrating 'outer-loop/inner-loop' control functions and for developing robust parallel-processing algorithms. Author

N93-23123*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
SUMMARY OF THE EFFECTS OF ENGINE THROTTLE RESPONSE ON AIRPLANE FORMATION-FLYING QUALITIES
KEVIN R. WALSH Washington Mar. 1993 26 p Presented at the AIAA 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992 Previously announced in IAA as A92-48902
(Contract RTOP 307-05-01)
(NASA-TM-4465; H-18880; NAS 1.15:4465; AIAA PAPER 92-3318) Avail: CASI HC A03/MF A01

A flight evaluation was conducted to determine the effect of engine throttle response characteristics on precision formation-flying qualities. A variable electronic throttle control system was developed and flight-tested on a TF-104G airplane with a J79-11B engine at the NASA Dryden Flight Research Facility. This airplane was chosen because of its known, very favorable thrust response characteristics. Ten research flights were flown to evaluate the effects of throttle gain, time delay, and fuel control rate limiting on engine handling qualities during a demanding precision wing formation task. Handling quality effects of lag filters and lead compensation time delays were also evaluated. The Cooper and Harper Pilot Rating Scale was used to assign levels of handling quality. Data from pilot ratings and comments indicate that throttle control system time delays and rate limits cause significant degradations in handling qualities. Threshold values for satisfactory (level 1) and adequate (level 2) handling qualities of these key variables are presented. These results may provide engine manufacturers with guidelines to assure satisfactory handling qualities in future engine designs. Author

N93-24087# Wright Lab., Wright-Patterson AFB, OH.
AN INTRODUCTION TO MULTIVARIABLE FLIGHT CONTROL SYSTEM DESIGN Final Report, Jan. - Oct. 1992
RICHARD J. ADAMS, JAMES M. BUFFINGTON, ANDREW G. SPARKS, and SIVA S. BANDA Oct. 1992 185 p
(Contract AF PROJ. 2304)
(AD-A260408; WL-TR-92-3110) Avail: CASI HC A09/MF A02

Background, theory, and examples for full envelope manual flight control system design is presented. An overview of aircraft dynamics and flying qualities is given to provide a basic understanding of the manual flight control problem. Details of available control design and analysis methods are presented to give the reader the required theoretical background. An inner/outer loop control structure is proposed to achieve full envelope flight control designs. Generalized controls are implemented through the use of a control selector. An inner equalization loop is used to linearize the input/output behavior of the aircraft across the flight envelope. A robust outer loop achieves the desired level of flying qualities. This approach provides a versatile framework for the application of advanced multivariable control theory to aircraft control problems. The engineer has the freedom to choose any method which achieves the design goals. The utility of this controller structure is demonstrated in its successful application to full envelope manual flight control problems for the VISTA F-16 test

aircraft and a supermaneuverable F-18 fighter. The results of linear robustness and performance analysis as well as nonlinear simulations are presented for the design examples. GRA

N93-24153# Aeronautical Research Labs., Melbourne (Australia).
VARIABLE CONTROL SYSTEM LIMITS ON BLACK HAWK AND SEAHAWK HELICOPTERS
J. BLACKWELL, S. DUTTON, R. TOFFOLETTO, and J. F. HARVEY Oct. 1992 39 p
(AD-A259624; ARL-FLIGHT-MECH-R-191; DODA-AR-007-083)
Avail: CASI HC A03/MF A01

Black Hawk and Seahawk helicopters have various fixed physical control limits situated throughout the control system. The range of each pilot control is variable and depends on which limit is reached first. This is a function of the pilot control inputs applied, together with any additional control inputs provided by the automatic flight control system. A procedure was developed to monitor controls in the vicinity of each limit, and determine if any part of the control system approaches to within a prescribed amount of a limit. Warning lights in the cockpit inform the pilot if a limit is being approached. The procedure was used effectively during a First of Class Flight Trial involving a Black Hawk. GRA

N93-24241# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
STABILITY OF ELASTICALLY TAILORED ROTOR SYSTEMS Final Report, 1 Dec. 1988 - 30 Sep. 1992
DEWEY H. HODGES, LAWRENCE W. REHFIELD, and MARK V. FULTON 30 Nov. 1992 10 p
(Contract DAAL03-89-K-0007)
(AD-A260550; ARO-25327.6-EG) Avail: CASI HC A02/MF A01

In this work the objectives included: (1) the development of models and analysis methodology for rotor stability in hover, incorporating all relevant nonclassical structural effects; (2) the validation of the models and analysis methodology, including convergence; and (3) the conduct of limited design studies with the tools developed in order to enhance understanding of the role of elastic couplings on stability. All these objectives were met. The final report contains a brief summary description of the results of the work. Details may be found in the published papers listed at the end of the report. GRA

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A93-31432
HYPERSONIC SHOCK-TUNNEL TESTING AT AN EQUILIBRIUM INTERFACE CONDITION OF 4100 K
M. A. S. MINUCCI (Centro Tecnico Aeroespacial, Inst. de Estudos Avancados, Sao Jose dos Campos, Brazil) and H. T. NAGAMATSU (Rensselaer Polytechnic Inst., Troy, NY) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 7, no. 2 Apr.-June 1993 p. 251-260. Previously cited in issue 17, p. 2868, Accession no. A91-42560 Research supported by Brazilian Air Force refs
Copyright

A93-31618
WINDTUNNEL EXPERIMENTAL INVESTIGATION OF A HIGH PERFORMANCE AIRCRAFT MODEL
G. GUGLIERI and F. QUAGLIOTTI (Torino, Politecnico, Turin, Italy) Aeronautical Journal (ISSN 0001-9240) vol. 97, no. 962 Feb. 1993 p. 73-80. refs
Copyright

In this paper some experimental results related to a calibration model (the Standard Dynamics Model, SDM) are presented. The wind tunnel test activity is based on static force measurements and flow visualizations. The behavior of the fuselage on its own is analyzed and a correlation with some available prevision theories for the onset of asymmetries on ogival forebodies is proposed. A complete set of static data for the SDM is introduced, evaluating the main aerodynamic interactions between the various elements of the configuration. A series of flow visualization was performed to verify with qualitative results the validity of the conclusions found from the analysis of the static coefficients. Author

A93-31937
IMPROVEMENT AND MODERNIZATION OF SUBSONIC WIND TUNNELS
T. WOLF (Darmstadt Technical Univ., Germany) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 57-63. AIAA, Aerodynamic Ground Testing Conference, 16th, Seattle, WA, June 18-20, 1990, AIAA Paper 90-1423. Previously cited in issue 16, p. 2492, Accession no. A90-37960 refs
(Contract BMFT-LVW-850217)
Copyright

A93-32195
A TEST BENCH FOR SMALL-SIZE POWERPLANTS OF PROPELLER-DRIVEN AIRCRAFT [ISPYTATEL'NYI STEND DLIA MALOGABARITNYKH SILOVYKH USTANOVOK DPLA]
V. P. ZUEV and M. A. KHRAMOV *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 61-69. In Russian.
Copyright

The general design, principal components, and operation of a test bench developed for the testing of propeller powerplants with a power of 7.35-29.4 kW and a thrust up to 1000 N are described. Test results are presented for the MAI-250-3 powerplant, developed for a VTOL aircraft. The tests have demonstrated the satisfactory operation of practically all systems of the test bench. The power of the tested powerplant is 11.6 kW at 4980 rpm. AIAA

A93-32691
DEVELOPMENT OF A 2M ROTOR MODEL TEST SYSTEM
SHOUSHEN LIU, SHILONG GUO, and XIAOGU ZHANG (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 48-56. In Chinese.

The design consideration and in characteristics of an advanced 2m rotor model test system developed by Nanjing Aeronautical Institute are introduced. The rotor model, control and excitation system, power and transmission system, measurement system, data acquisition and processing system, safety and warning system, display system, and master console are briefly described. The vibration control, rotor balance calibration, blade pitch control, and bearing temperature rise during the adjustment phase are introduced. The results fulfill the test requirements, and the development of the test system is found to be successful. AIAA

N93-22393# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Hubschrauber und Flugzeuge.
VISUAL SYSTEM PERFORMANCE FOR DRIVING SIMULATORS
U. FLIGGE, M. SOODEEN, and K. MOEBES Apr. 1992 8 p
(MBB-FE-521-S-PUB-0497; ETN-93-93439) Avail: CASI HC A02/MF A01

Visual system features which are necessary in providing effective visual cues to a driver are addressed. A selected number of applications for driver simulators are described and associated to a class of visual systems. A medium class visual system is then used to create a basis for a definition between required driver visual cues and visual system performance and features. Driver simulation application is concluded as presenting a great challenge to the visual system because of its complexity. The variation of requirements demand that the visual system be based upon a modular design (multichannel system, varying channel

resolution) and support a range of system features (z buffer, texture, three dimensional fixed/moving objects, footprint elevation, and fading algorithm). Other features which enhance the acceptance of a visual system as an information source for a driver are the scene update rate and video output format. ESA

N93-22666# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Hauptabt. Verkehrsforschung.
A METHOD FOR ESTIMATING FUTURE RUNWAY CAPACITY OF GERMAN AIRPORTS FOR SINGLE RUNWAY SYSTEMS [EIN PROGNOSETAUGLICHES VERFAHREN ZUR ERMITTLUNG DER START- UND LANDEBAHNKAPAZITAETEN DEUTSCHER VERKEHRSFLUGHAEFEN FUER EINBAHNSYSTEME]
ECKHARD URBATZKA Oct. 1991 150 p In GERMAN
(ISSN 0939-2963)
(DLR-FB-91-38; ETN-93-91927) Avail: CASI HC A07/MF A02; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

A method for estimating runway capacity, defined as the maximum number of aircraft movements per hour, is presented. The method is based on real flight operations in the airport control zone by means of radar data. The method draws from empirical data of the international airports of the Federal Republic of Germany with their local and operational procedures. Both the total range of possible capacity values and the present respectively, future arrival or departure or arrival-departure capacity may be estimated by means of parameter variation. A comparison of future aircraft movements (forecast) with future runway capacity is therefore possible. In this way it can be ascertained, whether or not the forecast movements can be handled by the runway system of an airport. The method is limited to single runways at the moment; the extension to multiple runways is in process. ESA

N93-22675*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CHARACTERISTICS OF VERTICAL AND LATERAL TUNNEL TURBULENCE MEASURED IN AIR IN THE LANGLEY TRANSONIC DYNAMICS TUNNEL
ROBERT K. SLEEPER, DONALD F. KELLER, BOYD PERRY, III, and MAYNARD C. SANDFORD Mar. 1993 58 p
(Contract RTOP 505-63-50-15)
(NASA-TM-107734; NAS 1.15:107734) Avail: CASI HC A04/MF A01

Preliminary measurements of the vertical and lateral velocity components of tunnel turbulence were obtained in the Langley Transonic Dynamics Tunnel test section using a constant-temperature anemometer equipped with a hot-film X-probe. For these tests air was the test medium. Test conditions included tunnel velocities ranging from 100 to 500 fps at atmospheric pressure. Standard deviations of turbulence velocities were determined and power spectra were computed. Unconstrained optimization was employed to determine parameter values of a general spectral model of a form similar to that used to describe atmospheric turbulence. These parameters, and others (notably break frequency and integral scale length), were determined at each test condition and compared with those of Dryden and Von Karman atmospheric turbulence spectra. When the data were discovered to be aliased, the spectral model was modified to account for and 'eliminate' the aliasing. Author (revised)

N93-22797# MiTech, Inc., Pleasantville, NJ.
SOFT-GROUND ARRESTING SYSTEM FOR COMMERCIAL AIRCRAFT Interim Report
ROBERT COOK Feb. 1993 39 p
(DOT/FAA/CT-TN93/4) Avail: CASI HC A03/MF A01

A soft-ground arresting system provides an economical and nondestructive means for decelerating an aircraft that would otherwise be unable to stop safely within the confines of the runway including the safety or overrun area. This report validates a mathematical model developed to predict deceleration of an aircraft as it travels through a soft-ground arresting system. Full-scale tests were conducted at the Federal Aviation Administration Technical Center using the FAA's instrumented B-727 aircraft. The speed of the aircraft entering the beds ranged from 20 to 80 knots. The dimensions of the bed were as follows: foam thickness range was from 6 to 18 inches; test bed length was from 88 to 176 feet; width was always 40 feet. In each test the deceleration experienced by the aircraft was recorded in addition to its velocity, landing gear loads, and brake torque. The results of these tests showed that actual measured parameters from the aircraft were within 10 percent of the values predicted by the mathematical model; thus validating the accuracy of this model. The 18-inch-thick foam bed provided the most effective deceleration without exceeding the stresses encountered by the aircraft during normal operation. Fire and rescue equipment can maneuver and conduct emergency operations within the foam arrestor bed without difficulty. Author

N93-22874# Mitre Corp., McLean, VA. Center for Advanced Aviation System Development.
OPERATIONAL EVALUATION OF THE CONVERGING RUNWAY DISPLAY AID AT SAINT LOUIS Final Report
M. R. GILLIGAN and A. E. GROSS Dec. 1992 165 p
(Contract DTFA01-89-C-00001)
(MTR-92W0000217; DOT/FAA/RD-93/7) Avail: CASI HC A08/MF A02

This report describes the evaluation of the Converging Runway Display Aid (CRDA) which has been used in an operational environment at Lambert-St. Louis International Airport since December 1990. The intent of the evaluation has been to determine the operational benefits of using CRDA at St. Louis and to assess the operational suitability of the aid for national implementation at those airports which have converging or intersecting runway configurations. As a result of the evaluation, the following was determined: the CRDA computer/human interface is operationally suitable; use of CRDA can increase airport capacity, and that with the DCIA procedures an acceptable margin of safety is provided. This report supports the decision to proceed with the national implementation of CRDA and provides guidance material for potential users of the aid. Author

N93-23087# Heli-Air, Inc., Broussard, LA.
ICING CLOUD SIMULATOR FOR USE IN HELICOPTER *ENGINE INDUCTION SYSTEM ICE PROTECTION TESTING*
S. W. BRUNNENKANT Dec. 1992 53 p
(DOT/FAA/CT-TN92/43) Avail: CASI HC A04/MF A01

Aircraft with Airborne Icing Spraying Systems (AISS) have been used for some time to generate icing clouds into which test aircraft could be flown to show compliance with the requirements of FAR XX.1093. However, the spray arrays used and the relatively large distance between the AISS and aircraft parts to be tested precluded small droplet sizes at high liquid water content at most atmospheric conditions. Some of these shortcomings were overcome by mounting the AISS directly on the test aircraft. This proved to be a very efficient method to develop and certify individual aircraft components. This report describes the methodology and test procedure used with an AISS mounted on a test aircraft to show compliance with FAR 29.1093 for the newly developed inlet of the Bell 222/250-C30G helicopter conversion. Development and certification testing was accomplished in a 4-week period. Author

N93-23114# Department of National Defence, Ottawa (Ontario). Directorate of Strategic Analysis.
AN ASSESSMENT OF PERMAFROST CONDITIONS AT THREE DND AIRPORTS IN ARCTIC CANADA AS THEY PERTAIN TO FUTURE PLANNING AND OPERATIONS
C. M. TUCKER and A. S. JUDGE (Geological Survey of Canada, Ottawa, Ontario.) Jul. 1991 48 p
(Contract ORAE PROJ. 44107)
(ORAE-R107; CTN-93-60665) Avail: CASI HC A03

Over a cycle of seasons, ground penetrating radar studies were carried out at Arctic airports in Inuvik, Rankin Inlet, and Alert, Northwest Territories. Two of the airports were slated for significant upgrading of runways, taxiways, and parking aprons, providing a

good opportunity to investigate the extent of permafrost and its seasonal variation at three locations distributed over a wide geographic area. The study method involved specific and repeated traverses with a Pulse EKKO 3 ground penetrating radar unit. The survey was successful in locating massive ice bodies, in imaging several existing problem areas beneath runways, and mapping the seasonal depth of thaw in permafrost. The study results imply that future monitoring at the sites should be continued in light of suggested ground stability problems due to global warming.
Author (CISTI)

N93-23128# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
GEOGRID REINFORCED BASE COURSES FOR FLEXIBLE PAVEMENTS FOR LIGHT AIRCRAFT: TEST SECTION CONSTRUCTION, BEHAVIOR UNDER TRAFFIC, LABORATORY TESTS, AND DESIGN CRITERIA Final Report
STEVE L. WEBSTER Dec. 1992 100 p
(Contract DTFA01-89-Z-02029)
(DOT/FAA/RD-92/25) Avail: CASI HC A05/MF A02

The results of a literature review investigating geogrid reinforced base courses for flexible pavements for light aircraft and the design of a geogrid test section for field testing the validity of potential geogrid reinforcement results have been previously reported. The construction of the field test section, the behavior of the test section under traffic testing using a 30,000 lb single tire load, the data collected, laboratory tests that were conducted on the various geogrid products used in the field test section, and development of design criteria for geogrid base reinforcement for flexible pavements for light aircraft are described. Test results verified the validity of geogrid reinforced base courses for flexible pavements for light aircraft. A geogrid reinforcement product equivalent to the SS-2 geogrid used in the field tests can reduce the total pavement design thickness. The geogrid performance is a function of depth of placement. The thickness reductions range from approximately 40 percent for unreinforced pavement thicknesses of 11 in. to 5 percent for 20-in.-thick pavements. The geogrid reinforcement performs best when placed between the base course and subgrade. The improvement mechanisms for geogrid reinforcement include grid interlock with aggregate base material, subgrade confinement, and to some extent a tensioned membrane effect. The geogrid property requirements for optimum performance are not totally known at this time. The performance of the various geogrid products tested ranged from no improvement up to a 40 percent reduction in total pavement thickness requirement. A relatively rigid sheet-type product (SS-2) performed the best.
Author (revised)

N93-23137# Nevada Univ., Reno. Dept. of Civil Engineering.
TEST REQUIREMENTS FOR COAL-TAR MIXTURES ON AIRPORT PAVEMENTS Final Report, May 1991 - Oct. 1992
PETER E. SEBAALY, VENU THIRMARAYAPPA, and JON EPPS Jan. 1993 46 p
(Contract DTFA01-91-P-07315)
(DOT/FAA/RD-92-27) Avail: CASI HC A03/MF A01

The research documented represents an effort to evaluate the test procedures for coal tar mixtures. The various coal tar test methods were evaluated under several levels of test variables. The freeze-thaw and scuff resistance tests were evaluated under three types of shingles and an aluminum substrate. The fuel resistance test was evaluated under three levels of sand loading and three levels of film thickness. In addition, all of the tests were evaluated under two levels of humidity. The analysis of the data indicates that the effect of the substrate is insignificant in all of the tests. The effect of humidity is significant on some tests, while the effects of sand loading and film thickness are highly significant on the results of the fuel resistance tests.
Author (revised)

N93-23217# Aviation Simulations International, Inc., Huntington, NY.
MULTIPATH RUNWAY EXITS AND TAXIWAYS Final Report
EVERETT S. JOLINE Jan. 1993 108 p Prepared for MiTech, Inc., Atlantic City, NJ
(Contract DTFA03-90-C-00036)
(DOT/FAA/CT-92/19) Avail: CASI HC A06/MF A02

As the level of air traffic demand increases in the future, and as advances are made in air traffic control technology to accommodate this traffic, the congestion resulting from aircraft moving on the ground may well become the limiting factor in airport capacity. A family of multipath concepts, based on the use of parallel redundancy for the key components of the airfield system, has been proposed as a means of ameliorating these problems. With these concepts, the number of runway crossings, departure queues, runway exits, and taxiways to/from gates would be increased to the design practices of today. An airport simulation model is used in this study to demonstrate each of the proposed concepts, as applied to six existing U.S. airports, and to develop quantitative estimates of the benefits of reducing delay and increasing throughput. The results show that while significant improvements in performance can be obtained, the application of a particular concept to a particular airport depends heavily on the characteristics of that airport. The study also demonstrates how simulation can be used as an effective tool for evaluating airport improvement alternatives at a specific airport. Author

N93-23420*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERFORMANCE AND TEST SECTION FLOW CHARACTERISTICS OF THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX 80- BY 120-FOOT WIND TUNNEL
PETER T. ZELL Jan. 1993 66 p
(Contract RTOP 505-50-28)
(NASA-TM-103920; A-92058; NAS 1.15:103920) Avail: CASI HC A04/MF A01

Results from the performance and test section flow calibration of the 80- by 120-Foot Wind Tunnel are presented. Measurements indicating the 80- by 120-ft test section flow quality were obtained throughout the tunnel operational envelope and for atmospheric wind speeds up to approximately 20 knots. Tunnel performance characteristics and a dynamic pressure system calibration were also documented during the process of mapping the test section flow field. Experimental results indicate that the test section flow quality is relatively insensitive to dynamic pressure and the level of atmospheric winds experienced during the calibration. The dynamic pressure variation in the test section is within +/-75 percent of the average. The axial turbulence intensity is less than 0.5 percent up to the maximum test section speed of 100 knots, and the vertical and lateral flow angle variations are within +/-5 deg and +/-7 deg, respectively. Atmospheric winds were found to affect the pressure distribution in the test section only at high ratios of wind speed to test section speed. Author (revised)

N93-24493*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN INTEGRATED ROTORCRAFT AVIONICS/CONTROLS ARCHITECTURE TO SUPPORT ADVANCED CONTROLS AND LOW-ALTITUDE GUIDANCE FLIGHT RESEARCH
ROBERT A. JACOBSEN, DOUGLAS H. DOANE, MICHELLE M. ESHOW (Army Aviation Systems Command, Saint Louis, MO.), EDWIN W. AIKEN, and WILLIAM S. HINDSON Oct. 1992 19 p Presented at the Digital Avionics Conference, Seattle, WA, 5-8 Oct. 1992 Prepared in cooperation with U.S. Army Aviation Systems Command, St. Louis, MO
(Contract RTOP 505-59-36)
(NASA-TM-103983; A-93000; NAS 1.15:103983) Avail: CASI HC A03/MF A01

Salient design features of a new NASA/Army research rotorcraft--the Rotorcraft-Aircrew Systems Concepts Airborne Laboratory (RASCAL) are described. Using a UH-60A Black Hawk helicopter as a baseline vehicle, the RASCAL will be a flying laboratory capable of supporting the research requirements of major NASA and Army guidance, control, and display research programs. The paper describes the research facility requirements of these programs together with other critical constraints on the design of the research system. Research program schedules demand a

phased development approach, wherein specific research capability milestones are met and flight research projects are flown throughout the complete development cycle of the RASCAL. This development approach is summarized, and selected features of the research system are described. The research system includes a real-time obstacle detection and avoidance system which will generate low-altitude guidance commands to the pilot on a wide field-of-view, color helmet-mounted display and a full-authority, programmable, fault-tolerant/fail-safe, fly-by-wire flight control system. Author

N93-24601* National Aeronautics and Space Administration. Pasadena Office, CA.
MOTION MEASUREMENT OF ACOUSTICALLY LEVITATED OBJECT Patent
JOHN L. WATKINS, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) and MARTIN B. BARMATZ, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 20 Apr. 1993 5 p Filed 25 Feb. 1991
(NASA-CASE-NPO-18191-1-CU; US-PATENT-5,203,209; US-PATENT-APPL-SN-660380; US-PATENT-CLASS-73-505; INT-PATENT-CLASS-G01P-13/04) Avail: US Patent and Trademark Office

A system is described for determining motion of an object that is acoustically positioned in a standing wave field in a chamber. Sonic energy in the chamber is sensed, and variation in the amplitude of the sonic energy is detected, which is caused by linear motion, rotational motion, or drop shape oscillation of the object. Apparatus for detecting object motion can include a microphone coupled to the chamber and a low pass filter connected to the output of the microphone, which passes only frequencies below the frequency of sound produced by a transducer that maintains the acoustic standing wave field. Knowledge about object motion can be useful by itself, can be useful to determine surface tension, viscosity, and other information about the object, and can be useful to determine the pressure and other characteristics of the acoustic field.
Official Gazette of the U.S. Patent and Trademark Office

N93-24643 Tana-Jyra, Ky (Finland).
BOGIE-GRIPPING TRANSFER DEVICE Patent Application
MATTI SINKKONEN, inventor (to Tana-Jyra) 5 Mar. 1992 17 p
(CA-PATENT-APPL-SN-024586; INT-PATENT-CLASS-B64F-1/10; CTN-93-60682) Copyright Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada, HC

A transfer device for gripping bogie wheels is discussed. The device will be used to move an aircraft or other wheeled device on a base. The device includes a frame section on which friction rollers that grip the bogie wheel are supported. Motors are provided to rotate at least three friction rollers for each wheel, and pressure devices are provided to press the friction rollers against the wheel. The device includes a power device, transmission devices to provide the motors with power, and devices to place the friction rollers around the wheels and to remove them. The placing devices of the friction rollers are attached to horizontal slides placed on one or more frame beams, so that the friction rollers are able to settle in a position corresponding to the distance between the axles of the set of bogie wheels. The device is applicable to bogie wheels of different sizes and with different distances between the axles, and the distribution of loading over several friction rollers enables minimization of the force per roller directed to the wheel.
Author (CISTI)

N93-24644 Tana-Jyra, Ky (Finland).
WHEELED TRANSFER DEVICE FOR MOVING AN AIRCRAFT Patent Application
MATTI SINKKONEN, inventor (to Tana-Jyra) 5 Mar. 1992 10 p
(CA-PATENT-APPL-SN-2-024584; INT-PATENT-CLASS-B64F-1/10; CTN-93-60684) Copyright Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada, HC

A transfer device that is equipped with support wheels to move an aircraft or other device equipped with double wheels over a base is discussed. The device includes at least one so-called self-wedging friction roller which grips the wheels of the device beneath the axle, and two support wheels which drive at essentially the same peripheral velocity in the opposite direction. In the transfer device, these two driving support wheels are located close to the line of the friction roller. The transfer device of the invention includes a pushing section with its own wheels, power source, drive, and steering devices. The friction rollers and driving support wheels are located in a transfer unit connected to the pushing section by means of a boom. The boom is connected to the transfer unit by means of a vertical joint and to the pushing unit by means of a horizontal joint. Author (CISTI)

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A93-31142
SELECTION OF MODELS IN THE PROBLEM OF ERROR PREDICTION FOR NAVIGATION SYSTEMS [SELEKTSIIA MODELEI V ZADACHE PROGNOZA OSHIBOK NAVIGATSIONNYKH SISTEM]
K. A. NEUSYPIN and K. A. PUPKOV *In* Intelligent systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 16-24. In Russian. refs
Copyright

A selection criterion based on the use of a criterion of observability degree is proposed for inertial navigation system. Models are selected that have a maximum degree of observability, which is determined from the maximum value of the square of the determinant of the observability matrix or the observability Grammian in the nonstationary case. Model reduction is carried out using a numerical criterion for the observability degree. L.M.

A93-31153
A METHOD FOR DERIVING THE REFERENCE TRAJECTORY OF A DESCENDING FLIGHT VEHICLE [METOD FORMIROVANIIA OPORNOI TRAEKTORII SPUSKAEMOGO LETATEL'NOGO APPARATA]
T. K. SIRAZETDINOV, V. I. KISELEV, and A. S. MESHCHANOV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 10-14. In Russian. refs
Copyright

A method is proposed for reducing a multicriterial nonsmooth main control problem to a single-criterion smooth problem. The sufficient conditions for solving the terminal guidance problems are determined. A procedure is presented for deriving optimal control using nonlinear programming methods and a specially developed set of applied software. V.L.

A93-31641
SPACEBORNE SURVEILLANCE RADAR - NEW CONCEPTS
M. ABBATI and G. GALATI (Roma II, Univ., Rome, Italy) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 52-55. refs
Copyright

New concepts and tools to design both primary-surveillance-radar and SSR spaceborne radars are addressed. Attention is given to the antenna requirements and

techniques, the overall design of the primary and secondary radars, and the side-lobes reduction problem. It is argued that it is possible to design a near-optimum system configuration (minimum complexity and cost with the required performance) both for primary and secondary space-based radars. The random array architecture is found to be able to meet all system requirements. AIAA

A93-31790
OPTIMIZED SCRAMJET INTEGRATION ON A WAVERIDER
MARY K. L. O'NEILL and MARK J. LEWIS (Maryland Univ., College Park) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1114-1121. AIAA, Fluid Dynamics, Plasma Dynamics and Lasers Conference, 22nd, Honolulu, HI, June 24-26, 1991, AIAA Paper 91-1693. Previously cited in issue 18, p. 3063, Accession no. A91-43594 Research supported by Univ. of Maryland and Zonta International Foundation refs
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A93-32232
CORRECTION OF INERTIAL NAVIGATION WITH LORAN C ON NOAA'S P-3 AIRCRAFT
JEFFREY M. MASTERS and JAMES A. LEISE (NOAA, Aircraft Operations Center, Miami, FL) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572) vol. 10, no. 2 April 1993 p. 145-154. refs
Copyright
The NOAA maintains two Orion WP-3D aircraft for atmospheric and oceanographic research; good navigation is essential to such research, and we show that Loran C, combined with inertial navigation, results in substantial improvements. In particular, a method based upon symmetric filters can, in postprocessing, correct for inertial navigation errors in position, velocity, and horizontal winds. To test this method, data are compared with a high-precision, ground-based laser system operated by NASA. Results show that errors in position and ground speed can be reduced to 0.2 km and 0.1-0.3 m/s, respectively, in regions of good Loran C coverage. In addition, errors in heading are analyzed, and a method for partially correcting errors, based solely upon Loran C data, is presented. Results show that wind calculations are adversely affected and errors may be fully corrected only with another, more accurate source of heading, or with a Kalman filtering approach. Author

A93-33389
MATHEMATICAL MODEL OF THE THREE-DIMENSIONAL MOTION OF FLIGHT VEHICLES WITH ALLOWANCE FOR WIND AND THE EARTH CURVATURE AND ROTATION [MATEMATICHESKAIA MODEL' PROSTRANSTVENNOGO DVIZHENIIA LA S UCHETOM VETRA, KRIVIZNY I VRASHCHENIIA ZEMLI]
V. P. SURIN, O. P. ZORINA, and N. S. NIKOLAENKO *In* Analysis and synthesis of complex dynamic systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 70-73. In Russian. refs
Copyright
A modular hierarchical structure of a mathematical model of the motion of a flight vehicle designed for computer implementation is proposed. The modular structure makes it possible to select the desired level of model complexity for a given stage of the flight vehicle trajectory. An analysis of various models of the motion of flight vehicles shows that a model in which equations of motion of the center of mass are written in trajectory coordinates and equations of angular motion in bound coordinates is particularly convenient computationally and can be easily structured in accordance with the proposed scheme. AIAA

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A93-30461
ON THE USE OF PROTECTIVE AIRCRAFT THERMOHELMETS FOR ACHIEVING HIGH SUPERSONIC SPEEDS
GENADY P. CHEREPANOV (Florida International Univ., Miami) Composites Engineering (ISSN 0961-9526) vol. 3, no. 4 1993 p. 321-327. refs
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Aircraft require protection from high stagnation temperatures during supersonic flight in dense atmospheres. This paper reviews several projects of disposable composite thermohelmets with smart-controlled and individually moving rods and analyzes unit-sintered ceramic thermohelmet structures. A computation of failure wave velocity in the steady-state brittle regime using eight physical parameters is presented. Results indicate that unit-sintered disposable thermohelmets made of alumina will provide safe protection for aircraft at high supersonic velocities. A.O.

A93-31415
EFFECT OF JOINT STIFFNESS ON PEEL STRENGTH OF DIFFUSION BONDED JOINTS BETWEEN AL-LI 8090 ALLOY SHEET
D. V. DUNFORD (Royal Aerospace Establishment, Farnborough, United Kingdom) and P. G. PARTRIDGE (Bristol Univ., United Kingdom) *Materials Science and Technology* (ISSN 0267-0836) vol. 8, no. 12 Dec. 1992 p. 1131-1140. refs
Copyright
The peel behavior of diffusion bonded joints between Al-Li 8090 alloy sheet depends upon joint geometry, sheet thickness, and the local stiffness of the bonded joint. The local stiffness was increased by bonding 8090 metal matrix composite onto the faces of the joint. At the superplastic forming temperature of 530 C the peel strengths of solid state or liquid phase diffusion bonded joints at peak load were increased from 5-7 N/mm to greater than 8 N/mm. This led to superplastic deformation of the sheet without peel fracture at the bonded joint. After air cooling and aging, the corresponding room temperature peel strengths were 174-252 N/mm, compared with 30-54 N/mm for an unstiffened joint, an increase by a factor of 3.2-8.4. It was concluded that stiffened bonded joints would enable multiple thin sheet structures to be manufactured in Al-Li 8090 alloy via a diffusion bonding/superplastic forming (DB/SPF) technique. A DB/SPF technique for a three sheet structure is described. Author

A93-31506
EXFOLIATION CORROSION TESTING OF ALUMINUM-LITHIUM ALLOYS
JAMES J. THOMPSON (U.S. Navy, Naval Air Development Center, Warminster, PA) *In* New methods for corrosion testing of aluminum alloys Philadelphia, PA American Society for Testing and Materials 1992 p. 70-81. refs
Copyright
A study was performed comparing the corrosion resistance of new aluminum alloys in shipboard environments with accelerated laboratory corrosion test environments. The aluminum-lithium (Al-Li) alloys tested were 2020-T651, 2090-T8E41, and 8090-T851. For comparison, 7075 aluminum was tested in the exfoliation susceptible T651 temper and the resistant T7351 temper. Accelerated laboratory tests performed were EXCO (ASTM G 34-86), sulfur dioxide salt fog (ASTM G 85.A4-85), and MASTMAASIS (ASTM G 85.A2-85). After shipboard exposure, the aluminum-lithium alloys in commercial tempers exhibited pitting corrosion similar to 7075-T7351. Aluminum alloy 7075-T651 exhibited severe exfoliation. During a mild shipboard exposure in

which 7075-T651 developed superficial exfoliation, 8090-T651 exhibited moderate exfoliation demonstrating these alloys are not inherently exfoliation resistant. Standard accelerated laboratory tests were effective predictors of performance in 7075 aluminum, but were not as effective for aluminum-lithium alloys. Author

A93-31964* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COHERENT ANTI-STOKES RAMAN SPECTROSCOPY TEMPERATURE MEASUREMENTS IN A HYDROGEN-FUELED SUPERSONIC COMBUSTOR
MICHAEL W. SMITH, OLIN JARRETT, JR., RICHARD R. ANTCLIFF, G. B. NORTHAM (NASA, Langley Research Center, Hampton, VA), ANDREW D. CUTLER (George Washington Univ., Hampton, VA), and DAVID J. TAYLOR (Los Alamos National Lab., NM) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 163-168. refs
Copyright

Coherent anti-Stokes Raman spectroscopy (CARS) thermometry has been used to obtain static temperature cross sections in a three-dimensional supersonic combustor flowfield. Data were obtained in three spanwise planes downstream of a single normal fuel injector which was located downstream of a rearward-facing step. The freestream flow was nominally Mach 2 and was combustion heated to a total temperature of 1440 K (yielding a static temperature of about 800 K in the freestream) to simulate the inflow to a combustor operating at a flight Mach number of about 5.4. Since a broadband probe laser was used an instantaneous temperature sample was obtained with each laser shot at a repetition rate of 10 Hz. Thus root-mean-square (rms) temperatures and temperature probability density functions (pdf's) were obtained in addition to mean temperatures. Author

A93-32153
EFFECT OF MICROPORE HEALING DURING A HIGH-TEMPERATURE GASOSTATIC TREATMENT ON THE MICROSTRUCTURE OF NICKEL SUPERALLOYS [VLIIANIE ZALECHIVANIIA MIKROPOR PRI VYSOKOTEMPERATURNOI GAZOSTATICHESKOI OBRABOTKE NA MIKROSTRUKTURU NIKELEVYKH SUPERSPLAVOV]
G. V. MAKHANEK, N. D. BAKHTEEVA, N. I. VINOGRADOVA, and S. N. PETROVA (RAN, Inst. Fiziki Metallov, Yekaterinburg, Russia) Fizika Metallov i Metallovedenie (ISSN 0015-3230) no. 11 Nov. 1992 p. 158-160. In Russian. refs
Copyright

Results of metallographic studies of gas turbine blades of nickel superalloys (EP 741, ZhS 6 U, and Inconel 738) subjected to a high-temperature gasostatic treatment in the as-cast condition or after tens of thousands of hours in service are reported. It is found that localized regions with a high dislocation density are formed in those microvolumes of metal where the healing of microporosity occurs. These dislocations may form a substructure as a result of redistribution or recrystallize during the treatment or subsequent heating. The resulting structural inhomogeneities may decrease the effectiveness of the high-temperature gasostatic treatment. AIAA

A93-32540
THE PROBLEMS OF FRETTING FATIGUE TESTING
ROBERT B. WATERHOUSE (Nottingham Univ., United Kingdom) *In* Standardization of fretting fatigue test methods and equipment Philadelphia, PA American Society for Testing and Materials 1992 p. 13-19. refs
Copyright

Fretting fatigue testing usually arises as the result of some failure which it is imperative to overcome either by a modified design or application of some surface treatment. In such cases the test rig is usually designed to replicate the actual situation as closely as possible, with environmental conditions as near to those occurring in practice. In laboratory testing the purpose is much wider, and usually entails, for instance, the assessment of different materials for their susceptibility to fretting damage, or the effect of variables such as clamping load, amplitude of slip and frequency, in particular environmental conditions. The type of fatigue test is very relevant. The nature of the contact is also material, as is the way in which the clamping stress is to be applied. Surface finish and residual stress are factors which must be taken into account. All these matters must be considered in devising a recommended testing procedure. Author (revised)

A93-32694
THE DEVELOPMENT AND FUTURE PROSPECT OF SMART COMPOSITE STRUCTURES WITH OPTICAL FIBRE NEURAL NETWORK SYSTEM
YONGJIANG XIANG (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 82-91. In Chinese. refs

Achievements in smart composite structures with embedded optical fibers which are going rapidly ahead in developed countries are described in this paper. The optical fiber system embedded in composite materials will become a neural network system in future aircraft structures, leading to new concepts of intelligent structures. This paper puts emphasis on measurement and monitoring of strain, deformation, curing, damage, and fatigue which are quite suitable for smart composite structures in fabrication, installation, and service. Author (revised)

A93-32951
AVIATION FUEL: THERMAL STABILITY REQUIREMENTS; PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM, TORONTO, CANADA, JUNE 26, 1991
PERRY W. KIRKLIN, ED. (Mobil Research & Development Corp., Paulsboro, NJ) and PETER DAVID, ED. (British Petroleum Co., PLC, Research Centre, Sunbury-on-Thames, United Kingdom) Philadelphia, PA American Society for Testing and Materials (ASTM Special Technical Publication, No. 1138) 1992 172 p. For individual items see A93-32952 to A93-32962
(ASTM STP-1138; ISBN 0-8031-1431-1) Copyright

Topics discussed in this symposium include the aviation engine considerations, the manufacturing and distribution considerations, the ASTM D 3241 Jet Fuel Thermal Oxidation Tester (JFTOT) test, and nonspecification tests for aviation fuel thermal stability. Individual papers are on thermal stability testing of aviation turbine fuel, physicochemical aspects of the aviation fuel thermal stability, the air frame considerations in fuel thermal stability for commercial supersonic flight, the high-temperature fuel requirements and payoffs, and the fuel thermal stability outlook for GE Aircraft Engines in 1991. Other papers are on the effect of manufacturing processes on the aviation-turbine-fuel thermal stability; a critical review of the JFTOT; simulation, precision, and decision in JFTOT testing; measures of fuel thermal stability, the development of a jet fuel thermal stability flow device which employs direct gravimetric analysis for both surface- and fuel insoluble deposits; and an automated device to quantitatively measure thermal deposits from JFTOT heater tubes by interferometry. AIAA

A93-32952
THERMAL STABILITY TESTING OF AVIATION TURBINE FUEL - A HISTORY
KURT H. STRAUSS *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 8-17. refs
Copyright

The paper traces the history of high temperature problems in aircraft jet fuel systems and outlines the parallel progress of fuel specifications to control the problems. The development of laboratory equipment to implement these controls is described together with the testing used to validate the control limits. Shortcomings of the various types of control equipment are reviewed. Author

A93-32953
PHYSICOCHEMICAL ASPECTS OF AVIATION FUEL THERMAL STABILITY
ROBERT N. HAZLETT (Hughes Associates, Inc., Wheaton, MD)

In Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 18-33. refs

Key physical and chemical factors affecting thermal stability of aviation fuel are examined using literature data. It was found that, among the physical factors which play a major role in the phenomena involved in the formation and deposition of insoluble material in jet aircraft fuel sytems, temperature is the most important parameter, followed by pressure, flow regime, and test duration. The most important chemical aspects are oxidation, fuel effects, and the effect of compounds containing hetero atoms. Several proposed mechanisms involved in the deposit formation are discussed. AIAA

A93-32956
FUEL THERMAL STABILITY OUTLOOK FOR GE AIRCRAFT ENGINES IN 1991
THEODORE F. LYON (GE Aircraft Engines, Cincinnati, OH) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 73-78. refs

The paper discusses several fuel thermal stability issues that are presently of particular concern to aircraft industry (and, in particular, to the GE Aircraft Engines). These issues include: the thermal-stability test procedures, engine fuel system temperatures, thermal stability trend of current fuels, and thermal stability of Soviet fuels (from the point of view of certification of western aircraft for Soviet fuels). It is noted that the present Jet Fuel Thermal Oxidation Test is not a good quantitative test for fuel thermal stability. The trend of fuel systems of current-development engines is toward higher fuel temperatures. This trend, combined with the possible trend toward poorer thermal stability of fuel, indicates potential future problems. AIAA

A93-32957
THE EFFECT OF MANUFACTURING PROCESSES ON AVIATION TURBINE FUEL THERMAL STABILITY
WILLIAM F. TAYLOR (Exxon Research and Engineering Co., Linden, NJ) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 81-89. refs

The effect of jet fuel manufacture processes on thermal stability quality is discussed in general terms. Processing sequences used to prepare jet fuel blend stocks vary widely depending on factors such as overall refinery design and crude type, and can have a significant effect on thermal stability quality. Processes which remove compounds which have a deleterious effect on thermal stability such as reactive olefins and heteroatom compounds have the greatest potential for thermal stability quality enhancement. Thus, hydrocracking and hydrotreating processes, in general, have greater potential for producing blend stocks with higher thermal stability quality than sweetening processes which convert mercaptans to disulfides which are left in the jet fuel. Treating with adsorbates such as Attapulgus clay also has the potential to remove deleterious compounds. Author

A93-32958
THE EFFECT OF MANUFACTURING PROCESSES ON AVIATION TURBINE FUEL THERMAL STABILITY - HANDLING
RODNEY FLETCHER (BP Oil, Hemel Hempstead, United Kingdom) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 90-93.

Thermal stability problems encountered over the past few years during the distribution of jet fuel will be reviewed. Surprisingly almost all of the problems have occurred during transportation by ship with very few being encountered with rail and multi-product pipeline movements. The reason for the failures will be discussed in relation to the distribution system and to the manufacturing processes. Author

A93-32959
CRITICAL REVIEW OF THE JFTOT
GUNTER DATSCHEFSKI (Esso Research Centre, Abingdon, United Kingdom) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 97-108.

The generation of JFTOT deposits and their subsequent assessment are reviewed, using results of a round-robin exercise involving four UK laboratories to study the precision of determining specification breakpoint temperature. A number of areas are identified in which the usefulness of the JFTOT as an aircraft fuel system simulator could be enhanced. Considerable variability was found in deposit assessment methods, and recommendations are made on how to overcome these for fuel research and specification purposes.

A93-32960
MEASURES OF FUEL THERMAL STABILITY - WHICH ANSWER IS CORRECT?
RICHARD H. CLARK (Shell Research, Ltd., Combustion and Fuels Dept., Chester, United Kingdom) and GEOFFREY J. BISHOP (Shell International Petroleum Co., Ltd., London, United Kingdom) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 117-137. refs

The paper describes three approaches to the investigation of thermal stability of jet fuels: (1) the use of large-scale rigs realistically simulating engine components and making it possible to predict the fuel performance in real environment; (2) critical examination of the JFTOT specification test, assessing its ability to predict the service fuel performance unequivocally; and (3) fundamental mechanistic studies (which include analyses of fuel composition and kinetic measurements of fuel oxidation) to provide the necessary chemical background for the studies. The advantages, disadvantages, and the nature of the measurements associated with each of these methods are described, and the differences between the various types of measurements are discussed. The results from these tests are used to develop a simple mechanism for thermal degradation of fuel. AIAA

A93-32961
DEVELOPMENT OF A JET FUEL THERMAL STABILITY FLOW DEVICE WHICH EMPLOYS DIRECT GRAVIMETRIC ANALYSIS OF BOTH SURFACE AND FUEL INSOLUBLE DEPOSITS
DENNIS R. HARDY, ERNA J. BEAL (U.S. Navy, Naval Research Lab., Washington), and JACK C. BURNETT (Geo-Centers, Inc., Fort Washington, MD) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 138-150. refs

This paper describes the development of a liquid flow reactor which is capable of emulating the JFTOT apparatus conditions but which is constructed of simple off-the-shelf components. This new gravimetric fuel thermal oxidation tester allows the determination of deposit weights directly, simply and nondestructively by gravimetry. This new device is quite compact and offsets fastly improved flexibility of operating conditions including a wide range of test temperatures, pressures, flows and reactant types. It is ideally constructed for the attachment of ancillary analytical devices. The results of tests with this device on 15 specification jet fuels at standard ASTM D3241 (Jet Fuel Thermal Oxidation Tester Procedure) conditions are presented.

The gravimetric tester yielded quantitative and repeatable measurements of both heater strip deposits and fuel insoluble concentrations. Author

A93-32999
NEW THERMOPLASTIC POLYIMIDE COMPOSITE FOR AIRCRAFT STRUCTURE
T. NAGUMO (Fuji Heavy Industries, Ltd., Aerospace Engineering Div., Utsunomiya, Japan) and H. SAKAI (Mitsui Toatsu Chemicals, Inc., Central Research Inst., Yokohama, Japan) *In* Advanced composite materials II Paris SIRPE and Les Techniques de l'Ingenieur 1991 p. 242-247. Research sponsored by Society of Japanese Aerospace Companies refs
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Thermoplastic-resin composites exhibit excellent processability and fracture toughness relative to thermoset-resin composites, and in addition offer enhanced heat resistance. Attention is presently given to a novel thermoplastic polyimide resin-based composite which has twice the hot/wet compression strength of an epoxy-based composite, as well as a compressive strength after impact of 36 kgf/sq mm. Accounts are given of the polyimide's processability and fabrication techniques. AIAA

A93-33046
CERAMIC MATRIX COMPOSITES FOR AERO-ENGINES
S. MASON, R. J. MINOR, and A. G. RAZZELL (Rolls-Royce, PLC, Advanced Ceramics Centre; Warwick Univ., Coventry, United Kingdom) Materials World (ISSN 0967-8638) vol. 1, no. 1 Jan. 1993 p. 16-18. refs
Copyright

A development status evaluation is presented for proprietary ceramic-matrix composite (CMC) fabrication techniques for gas turbine aircraft engine hot-section components. Attention is given to two CMC systems, SiC-reinforced SiC, and SiC-reinforced glass-ceramics, as well as to the CVI method for SiC/SiC. The types of loading that potential components will experience can be complex, requiring close cooperation between designers, stress analysts, and materials scientists. AIAA

N93-22603# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
RESIN TRANSFER MOLDING: AN ANSWER TO THE PROBLEM OF THE INDUSTRIALIZATION OF COMPOSITES. APPLICATION TO NACELLES AND THRUST REVERSE PARTS [RESIN TRANSFER MOLDING: UNE REPONSE AU PROBLEME DE L'INDUSTRIALISATION DES COMPOSITES. UNE APPLICATION AUX PIECES DE NACELLES ET INVERSEURS DE POUSSEE]
H. GIRARDY, S. A. BROCHIER, and DIDIER VIGNERON (Hispano-Suiza, Le Havre, France.) 1991 11 p In FRENCH Presented at AAAF 39th Salon International de Paris on Materiaux pour l'Aeronautique, Le Bourget, France, 14-23 Jun. 1991
(DS-2024; ETN-93-93395) Avail: CASI HC A03/MF A01

The application of the INJECTEX (trademark) procedure to the 1H/11H material of the CFM56-517 engine is reported. This procedure is based on Resin Transfer Modeling (RTM) technology which is used for the production of composite parts. RTM consists of injecting a resin into a mold containing reinforcing fibers. The differences between RTM and INJECTEX are outlined. The main difference being that INJECTEX involves the use of high performance technical fibers. The fibers and resins used in the INJECTEX procedure are described. The procedure is outlined giving details of the dry performing technology and the injection procedure. Results of tests of the mechanical properties of plates molded by the INJECTEX procedure are presented. The potential application to the following is considered: fittings in the interior of civil planes, exterior secondary parts, primary exterior parts, and engine parts. ESA

N93-22657# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Gruppe Zerstoerungsfrie Pruefung.
DEVELOPMENT AND PRODUCTION OF SANDWICH RODS WITH LOAD TRANSMITTING ELEMENTS CARRYING HIGH TENSION AND COMPRESSION LOADS [ENTWICKLUNG UND FERTIGUNG VON ZUG- UND DRUCKSTAEBEN AUS FASERVERBUNDWERKSTOFFEN MIT HOCHBELASTBAREN KRAFTEINLEITUNGEN]
RAINER SCHUETZE Aug. 1991 34 p In GERMAN
(ISSN 0939-2963)
(DLR-FB-91-33; ETN-93-91923) Avail: CASI HC A03/MF A01; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

It is shown that the structural weight of push rods used in commercial aircraft can be signficantly reduced by using Carbon Fiber Reinforced Plastics (CFRP) instead of aluminum. A simple substitution is not possible on account of the load transmission and the complex stress states generated by them. Besides stiffness and strength, the production costs are another important parameter. A form locking load transmission which can be adapted to standardized CFRP rods demonstrates how the properties of high strength and low structural weight can be combined with an economically advantageous wholescale production. ESA

N93-22709# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
MECHANISMS AND ENHANCEMENT OF FLAME STABILIZATION
C. K. LAW 1993 7 p
(Contract DE-FG02-89ER-13988)
(DE93-006467; DOE/ER-13988/5) Avail: CASI HC A02/MF A01

During the reporting period, useful contributions have been made in understanding the structure of laminar premixed and diffusion flames, with emphasis on the influence of aerodynamics and chemical kinetics. These contributions include: (1) derivation of the missing closure condition for the activation energy asymptotic analysis of premixed flames; (2) identification of a dual extinction mode for radiation-affected flames; (3) formulation of a unified theory of fundamental flammability limits; and (4) demonstration that flame stabilization can be achieved in the absence of heat loss. These investigations have been conducted via experimental, analytical and computational approaches, with strong coupling between the individual components. DOE

N93-23704# Naval Air Warfare Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
NON-CHROMATED SURFACE PRETREATMENTS FOR ALUMINUM Interim Report, Oct. 1989 - Jun. 1992
STEPHEN J. SPADAFORA 18 Aug. 1992 44 p
(AD-A260130; NAWCADWAR-92077-60) Avail: CASI HC A03/MF A01

Chromates, particularly chromium VI, have been widely used in aerospace processes and materials due to their excellent performance as corrosion inhibitors. These processes range from inorganic pretreatment processes (alkaline cleaners, deoxidizers, conversion coatings, etc.) to organic protective coatings (primers, sealants, fuel tank coatings, etc.). Recently, regulatory agencies have enacted legislation to limit or prohibit the use and disposal of chromium containing materials because chromium VI is now a known carcinogen. These rules affect the majority of the pretreatment processes used on naval aircraft, necessitating the development of non-chromated replacements for the current materials. After an extensive research and development effort, several promising alternatives to chromated alkaline cleaners, deoxidizers, and conversion coatings have been identified. As a result of this work, implementation of non-chromate cleaning and deoxidizing materials at Naval Aviation Depots have already resulted in significant cost savings in both processing and waste disposal. Full implementation of these alternatives at all naval levels of maintenance (organizational, intermediate, and depot facilities) will result in a major reduction of hazardous waste

generated by the Navy. This report describes the RDT and E effort to develop these non-chromated alternatives. GRA

N93-23941 Transportation Safety Board of Canada, Ottawa (Ontario).
THE CONSEQUENCE OF JOINT FAILURES
J. W. HUTCHINSON and D. C. ROCHELEAU *In* National Research Council of Canada, Airframe Materials p 87-98 Jul. 1991
Copyright Avail: Canadian Inst. of Mining, Metallurgy and Petroleum, Xerox Tower 1210, 3400 de Maisonneuve Blvd., Montreal, Canada, H3Z 3B8

Three case studies are presented which address the use of mechanical fasteners, adhesive bonding, and welding to form joints in aircraft materials and components. The cases demonstrate the severe consequences of a joint failure and how prevention might have been achieved through better quality control. The first case involved a Piper Aircraft crash following an engine power loss caused by a blocked air flow to the engine. The carburetor air valve had detached from the actuator shaft due to wear and failure of rivets attaching the valve to the shaft. In the second case, a Bell Helicopter lost control on liftoff due to separation of a tail rotor drive shaft from its coupling adapter. The separation was attributed to in-flight debonding of adhesive holding the shaft components together. The third case involved failure of the main rotor transmission output shaft in a Hughes Helicopter. The failure was attributed to fatigue in the upper disc of the shaft due to the presence of a metallurgical stress concentration caused by electron weld beam impingement on the inner surface of the disc.
Author (CISTI)

N93-23953# Boeing Defense and Space Group, Seattle, WA.
X-RAY COMPUTED TOMOGRAPHY FOR ADVANCED MATERIALS AND PROCESSES Interim Report, Aug. 1990 - May 1991
GARY GEORGESON and RICHARD BOSSI 30 Jun. 1992 56 p
(Contract F33615-88-C-5404)
(AD-A259828; WL-TR-91-4101) Avail: CASI HC A04/MF A01

Due to demanding requirements imposed on current and future high-performance aerospace structures, advanced materials are being developed for and used in a variety of aircraft/aerospace applications. Production costs for advanced materials are generally higher and the payback will be greater for data leading to faster decision making or improvement in the product. The development and qualification of new materials and joining and manufacturing processes for advanced aircraft/aerospace applications is accelerated by the availability of quantifiable data on design characteristics and their variations. X-ray computed tomography (CT) provides quantitative measurements of material characteristics in terms of the dimensions, density, and composition. The sensitivity of CT is dependent upon a number of factors including the test article and the CT system technology employed. The evaluation capability of CT overcomes the limitation of current qualitative inspection techniques to provide an objective measure of material or component condition. The results of studies involving CT testing of various advanced materials, manufacturing processes, and joining methods revealed four specific areas in which there is potential for significant economic benefit from CT. These areas are new product development, process control, noninvasive micrography, and material performance prediction. GRA

N93-24053# Aeronautical Research Labs., Melbourne (Australia).
DESIGNING FOR DAMAGE TOLERANT COMPOSITE REPAIRS
W. K. CHIU, D. REES, P. CHALKLEY, and R. JONES Oct. 1992 44 p
(AD-A260094; ARL-STRUC-R-448; DODA-AR-007-070) Avail: CASI HC A03/MF A01

This paper presents a design methodology, and the associated data base, for the damage tolerant design of adhesively bonded repairs. This methodology is illustrated by considering repairs to an edge cracked panel and to multi-site damage in a fuselage lap joint. GRA

N93-24332# Dayton Univ. Research Inst., OH.
COMBUSTION AND HEAT TRANSFER STUDIES UTILIZING ADVANCED DIAGNOSTICS: FUELS RESEARCH Final Report, 27 Feb. 1991 - 30 Sep. 1992
D. R. BALLAL, R. J. BYRD, S. P. HENEGHAN, C. R. MARTEL, and T. F. WILLIAMS Nov. 1992 198 p
(Contract F33615-87-C-2767)
(AD-A260249; WL-TR-92-2112) Avail: CASI HC A09/MF A03

As the Air Force continues to advance engine technology, aviation fuel heat loading has steadily increased. Therefore, a thermally stable JP-8 fuel is required that can operate at higher temperatures than current fuels. This research program had two objectives: to identify fundamental conditions of fuel thermal decomposition, and to provide the data needed to develop and evaluate global chemistry and heat transfer models for predicting jet fuel thermal decomposition and deposition rate. We successfully designed and performed numerous static and flowing experiments on a variety of JP fuels. These experiments illuminated the role of antioxidants, peroxides, ketones, and hetero-atom sulfur molecules in the oxidation of surrogate JP-8 and and jet fuels. We developed an autooxidation theory which distinguishes oxidative stability from thermal stability and accounts for the observed oxygen consumption and methane production. Also, we examined several additives and found a select few which produce the least deposits. Finally, our data led to the evaluation and refinement of global chemistry and heat transfer models for predicting jet fuel deposition rates. GRA

N93-24461# Argonne National Lab., IL.
OBTAINING HIGH-RESOLUTION IMAGES OF CERAMIC FROM 3-D X-RAY MICROTOMOGRAPHY BY REGION-OF-INTEREST RECONSTRUCTION
E. A. SIVERS, D. A. HOLLOWAY, and W. A. ELLINGSON 1992 11 p Presented at the 17th Annual *Conference on Composites* and Advanced Ceramics, Cocoa Beach, FL, 11-15 Jan. 1993
(Contract W-31-109-ENG-38)
(DE93-006796; ANL/MCT/CP-77181; CONF-930164-9) Avail: CASI HC A03/MF A01

3-D x-Ray imaging technology, when applied to advanced ceramics, is limited in some cases by detector sensitivity. This limitation can be overcome to some degree by the use of region-of-interest (ROI) reconstruction software. We have developed such software and applied it to 28 mm-diameter, injection-molded Si3N with known hole-type defects ranging in diameter from 25.4 to 508 microns. We have also applied the ROI concept to large (22 cm)-diameter Si3N4 turbocharger rotors, demonstrating the ability to resolve only the critical blade-hub region for each blade. DOE

N93-24472*# Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.
AN EXTENDED SUPERSONIC COMBUSTION MODEL FOR THE DYNAMIC ANALYSIS OF HYPERSONIC VEHICLES Interim Task Report
J. A. BOSSARD, R. E. PECK, and D. K. SCHMIDT Mar. 1993 31 p
(Contract NAG1-1341)
(NASA-CR-192716; NAS 1.26:192716; ARC-93-2) Avail: CASI HC A03/MF A01

The development of an advanced dynamic model for aeroelastic hypersonic vehicles powered by air breathing engines requires an adequate engine model. This report provides a discussion of some of the more important features of supersonic combustion and their relevance to the analysis and design of supersonic ramjet engines. Of particular interest are those aspects of combustion that impact the control of the process. Furthermore, the report summarizes efforts to enhance the aero-propulsive/aeroelastic dynamic model developed at the Aerospace Research Center of Arizona State University by focusing on combustion and improved modeling of this flow. The expanded supersonic combustor model described here has the capability to model the effects of friction, area change, and mass addition, in addition to the heat addition process. A comparison is made of

the results from four cases: (1) heat addition only; (2) heat addition plus friction; (3) heat addition, friction, and area reduction, and (4) heat addition, friction, area reduction, and mass addition. The relative impact of these effects on the Mach number, static temperature, and static pressure distributions within the combustor are then shown. Finally, the effects of frozen versus equilibrium flow conditions within the exhaust plume is discussed.
Author (revised)

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A93-29929
A MATHEMATICAL MODEL AND A CALCULATION METHOD FOR COOLING AIR MIXING IN A TURBINE
HONG YANG, ZHONGQI WANG, and GUOTAI FENG (Harbin Inst. of Technology, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 15-18. In Chinese. refs

A mathematic model is proposed for predicting the effect of injected cooling air on the cooled turbine performance. The model takes the gas flow as the mainstream flow and regards the cooling air as a consecutive source with continuous distribution in the flow field. A numerical method is presented for determining the intensity of the consecutive source. According to the model, the coupled aerothermodynamic equations reflecting the effect of the cooling air mixing in general form are derived in a relative coordinate system. As an example, the model is used in the throughflow calculation for the cooled turbine. The governing equations are derived along S2 stream surface in a nonorthogonal curvilinear coordinate system. By defining a quasi-stream function which satisfies the continuity equation, a line-relaxation calculation method is developed for the quasi-stream function. Author

A93-29938
RESEARCH ON 3-D DISCHARGE FLOW IN A CENTRIFUGAL IMPELLER
GUANG XI and SHANGJIN WANG (Xian Jiaotong Univ., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 49-52. In Chinese. refs

A method for calculating 3D discharge flow in a centrifugal impeller is developed by means of solving the incompressible steady time-averaged N-S equations, the continuity equation, and the k-epsilon turbulence model equation. This method is accomplished with calculation grids generated by an algebraic transformation, and thus it can be easily applied to the design analysis of centrifugal impellers. The discharge flow of a three-dimensional shrouded centrifugal compressor impeller was measured for assessing the validity of the present calculation procedure. The comparison between the experimental data and the calculation results shows that the present method can predict the mean velocities. Author

A93-29942
SURFACE TEMPERATURE MEASUREMENT OF TURBINE DISKS
HONGDAO WU, YUWU QU, XUNGGUANG LI, and SHENGQIN DU (Xian Aeroengine Corp., Design Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 63-66. In Chinese. refs

A new method of temperature measurement with a single-wire thermocouple - slip ring system is introduced to measure the surface temperature of the turbine disks in the turbojet engines, and the accuracy of this method is considered. In this case, the limited channels of the slip ring are fully utilized and the measured surface temperatures of the disk are actual and believable enough. The problems in its application, such as the installation of the thermocouples, the cooling of the slip ring, and the balance of the turbine rotor with this system, are discussed briefly. Author

A93-29997
HEAT TRANSFER TO IMPINGING ISOTHERMAL GAS AND FLAME JETS
R. VISKANTA (Purdue Univ., West Lafayette, IN) Experimental Thermal and Fluid Science (ISSN 0894-1777) vol. 6, no. 2 Feb. 1993 p. 111-134. Research supported by Gas Research Inst refs
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Heat transfer characteristics of single and multiple isothermal turbulent air and flame jets impinging on surfaces are reviewed. Both circular and slot two-dimensional jets are considered, and the effect of crossflow on impingement heat transfer is included. The emphasis is on physical phenomena and not on comparison of published empirical correlations or comparisons of theory and experiments. The review focuses on applications in the materials or comparisons of theory and experiments. The review focuses on applications in the materials processing field. In spite of the fact that there are many differences in the jet characteristics (i.e., axial velocity and turbulence intensity) of isothermal and flame jets, the stagnation point heat transfer of these different jets can be described in a similar way. Areas needing research attention are also identified. Author

A93-30000
FILM COOLING EXPERIMENTAL TECHNIQUE USING A LUDWIEG TUBE WIND TUNNEL
MING-YUAN ZHANG (Xian Jiaotong Univ., China), FU-KANG TSOU (Drexel Univ., Philadelphia, PA), XUE-JUN CHEN (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China), and SHIH-JIUN CHEN (Temple Univ., Philadelphia, PA) Experimental Thermal and Fluid Science (ISSN 0894-1777) vol. 6, no. 2 Feb. 1993 p. 186-195. refs
Copyright

The experimental technique of film cooling using a Ludwieg tube wind tunnel is reported. The main airflow is produced behind expansion waves, and the secondary flow from a pressurized tank is injected into the main-flow boundary layer through two staggered rows of holes. The combined short-duration flow reaches a steady state in a specially designed test section after a starting period of several milliseconds. Heat transfer measurements are conducted on a constant wall temperature boundary condition in both streamwise and spanwise directions using miniature platinum thin-film heat flux gauges constructed by the authors. From measured data, the film cooling effectiveness and the heat transfer coefficient are determined simultaneously. Test results compare well with those obtained from continuous wind tunnel experiments. Author

A93-30008
EXPERIMENTAL EVALUATION OF AN AIRBORNE DEPTH SOUNDING LIDAR
OVE STEINVALL, KURT KOPPARI, and ULF KARLSSON (Swedish Defense Research Establishment, Linkoping, Sweden) *In* Lidar for remote sensing; Proceedings of the Meeting, Berlin, Germany, June 24-26, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 108-126. Research supported by Defense Materiel Administration of Sweden refs
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An experimental evaluation of an airborne depth sounding lidar called FLASH (FOA Laser Airborne Sounder for Hydrography) is presented. The lidar is based on a scanning frequency doubled Nd-YAG laser and is borne by a helicopter. An example of measured waveforms is compared with those obtained by analytical and Monte Carlo modeling. C.A.B.

A93-30075
STRUCTURAL OPTIMIZATION: STATUS AND PROMISE
MANOHAR P. KAMAT, ED. (Georgia Inst. of Technology, Atlanta) Washington American Institute of Aeronautics and Astronautics, Inc. (Progress in Astronautics and Aeronautics. Vol. 150) (ISSN 0079-6050) 1993 903 p.
(ISBN 1-56347-056-X) Copyright

Chapters contained in this book include fundamental concepts of optimum design, mathematical programming methods for constrained optimization, function approximations, approximate reanalysis methods, dual mathematical programming methods for constrained optimization, a generalized optimality criteria method, and a tutorial and survey of multicriteria optimization in engineering. Also included are chapters on the compromise decision support problem and the adaptive linear programming algorithm, sensitivity analyses of discrete and distributed systems, the design sensitivity analysis of nonlinear structures, optimization by decomposition, mixed elements in shape sensitivity analysis of structures based on local criteria, and optimization of stiffened cylindrical shells subjected to destabilizing loads. Other chapters are on applications to fixed-wing aircraft and spacecraft, integrated optimum structural and control design, modeling concurrency in the design of composite structures, and tools for structural optimization. (No individual items are abstracted in this volume) I.S.

A93-30193
NONLINEAR ANALYSIS OF ANISOTROPIC RODS USING CURVATURE TRANSFORMATION AND INCLUDING WARPING
A. ROSEN, R. G. LOEWY, and M. B. MATHEW (Rensselaer Polytechnic Inst., Troy, NY) Computers & Structures (ISSN 0045-7949) vol. 45, no. 5-6 Dec. 3, 1992 p. 1001-1017. refs
(Contract DAAL03-88-C-0004)
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The study extends a model for analyzing the nonlinear behavior of isotropic rods so as to include anisotropic materials and a general accounting for warping of cross sections. Rigid movement of cross sections, such as those associated with pure extension and shear deformations due to transverse shear or torsion, are considered as special cases of warping, but rigid rotations which remain normal to the deformed neutral axis, such as those occurring in Euler-Bernoulli beam bending, are not. This results in a general and efficient model which is readily applicable in many cases. Examples of the model's utility are presented in the form of studies of the tension of a pretwisted rod and the bending of a beam with sandwich construction. Good agreement is obtained with exact analytic results, and modal convergence behavior is shown to be quite different for global deflection behavior, on the one hand, and local deflections of the cross sections, on the other, near boundaries with warping constraint, such as blade roots. P.D.

A93-30195
A STRUCTURAL DYNAMICS STUDY OF A WING-PYLON-TILTROTOR SYSTEM
N. KHADER and R. ABU-MALLOUH (Jordan Univ. of Science and Technology, Irbid) Computers & Structures (ISSN 0045-7949) vol. 45, no. 5-6 Dec. 3, 1992 p. 1061-1071. refs
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A simple structural model for a three-bladed tiltrotor-pylon-wing assembly is presented, which accounts for chordwise, transverse, and torsional wing deformations, rigid pylon pitching motion with respect to the wing tip cross-section in its deformed position, lead-lag, flap, and torsional deformations of rotor blades. The model considers equivalent viscous damping associated with blade and wing elastic deformations and with rigid pylon pitching motion. It is established that blade-to wing bending rigidity ratio, pylon pitching frequency, equivalent viscous damping associated with blade elastic deformations, and rotational speed, are the most important design parameters, whose effect on system frequencies and stability boundaries is evaluated. Author

A93-30200
LASERS LEAD THE SEARCH FOR CLEANER, MORE EFFICIENT COMBUSTION TECHNIQUES
KATE LEGGETT (Spectra-Physics Lasers, Mountain View, CA) Photonics Spectra (ISSN 0731-1230) vol. 26, no. 11 Nov. 1992 p. 99-102, 104, 105. refs
Copyright

The use of laser diagnostics for the investigation of combustion techniques and combustion chemistry reactions is reviewed. Flow visualization techniques and imaging of large-scale turbulent structures are discussed. Planar laser-induced fluorescence (PLIF) and its applications in laser diagnostics and analysis of combustion chemistry are described. Future applications of flow visualization and PLIF are discussed. A.O.

A93-30291* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SURFACE PRESSURE FIELD MAPPING USING LUMINESCENT COATINGS
B. G. MCLACHLAN (NASA, Ames Research Center, Moffett Field, CA), J. L. KAVANDI, J. B. CALLIS, M. GOUTERMAN, E. GREEN, G. KHALIL, and D. BURNS (Washington Univ., Seattle) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 1-2 1993 p. 33-41. refs
Copyright

In recent experiments we demonstrated the feasibility of using the oxygen dependence of luminescent molecules for surface pressure measurement in aerodynamic testing. This technique is based on the observation that for many luminescent molecules the light emitted increases as the oxygen partial pressure, and thus the air pressure, the molecules see decreases. In practice the surface to be observed is coated with an oxygen permeable polymer containing a luminescent molecule and illuminated with ultraviolet radiation. The airflow induced surface pressure field is seen as a luminescence intensity distribution which can be measured using quantitative video techniques. Computer processing converts the video data into a map of the surface pressure field. The experiments consisted of evaluating a trial luminescent coating in measuring the static surface pressure field over a two-dimensional NACA-0012 section model airfoil for Mach numbers ranging from 0.3 and 0.66. Comparison of the luminescent coating derived pressures were made to those obtained from conventional pressure taps. The method along with the experiment and its results will be described. Author

A93-30393
A 'ROBUST' VORTEX-SHEDDING ANEMOMETER
A. PAPANGELOU (Cambridge Univ., United Kingdom) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 3 1993 p. 208-210. refs
Copyright

A vortex-shedding device was developed for monitoring low air speeds. Two devices were calibrated to cover the speed range of 0.4 to 1.3 m/s. Results are presented and discussed. The anemometer exhibited several advantages over other speed-measuring devices but may not be suitable for the measurement of non-uniform of highly turbulent flows. A.O.

A93-30398
A COMPLETE BOUNDARY INTEGRAL FORMULATION FOR STEADY COMPRESSIBLE INVISCID FLOWS GOVERNED BY NON-LINEAR EQUATIONS
ZUOSHENG YANG (Nanjing Aeronautical Inst., China) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 16, no. 3 Feb. 15, 1993 p. 231-237. refs
Copyright

A complete boundary integral formulation for steady compressible inviscid flows governed by nonlinear equations is established by using the specific mass flux as a dependent variable. Thus, the dimensionality of the problem to be solved is reduced by one and the computational mesh to be generated is needed only on the boundary of the domain. It is shown that the boundary integral formulation developed in this paper is equivalent to the

results of distributions of the fundamental solutions of the Laplacian operator equation with a different order along the boundaries of the domain. Hence, we have succeeded in establishing the fundamental-solution method for compressible inviscid flows governed by nonlinear equations. Author

A93-30513*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BOUNDARY LAYER TRANSITION DETECTION BY LUMINESCENCE IMAGING
B. G. MCLACHLAN, J. H. BELL (NASA, Ames Research Center, Moffett Field, CA), J. GALLERY, M. GOUTERMAN, and J. CALLIS (Washington Univ., Seattle) Jan. 1993 19 p. AIAA, Aerospace Sciences Meeting and Exhibit, 31st, Reno, NV, Jan. 11-14, 1993 refs
(AIAA PAPER 93-0177) Copyright

In recent experiments we have demonstrated the feasibility of a new approach to boundary layer transition detection. This new approach employs the temperature dependence of certain photoluminescent materials in the form of a surface coating or 'paint' to detect the change in heat transfer characteristics that accompany boundary layer transition. The feasibility experiments were conducted for low subsonic to transonic Mach numbers on two-dimensional airfoil and flat plate configurations. Paint derived transition locations were determined and compared to those obtained from Preston pressure probe measurements. Artificial heating of the models was used to obtain transition temperature signatures suitable for the instrumentation available to us. Initial estimates show, however, that passive kinetic heating at high Mach numbers is a promising alternative. Author

A93-30563
NUMERICAL ANALYSIS OF FLOW FIELD AROUND GAS RUDDER
LIBIN MA and HONGQING HE (Northwestern Polytechnical Univ., Xian, China) Journal of Propulsion Technology (ISSN 1001-4055) no. 1 Feb. 1993 p. 28-33. In Chinese. refs

Two-dimensional flow field around the cross section of gas rudder in gas flow direction is calculated. In calculation, the flow field is divided into three regions, subsonic-transonic region I behind curved shock wave around blunt-nosed body, supersonic region II behind curved shock wave, and supersonic flow region III behind expansion wane. The strip-band method, the characteristic method, and the Prandtl-Meyer formula are used to calculate flow parameters in terms of the consideration of aerodynamics, thermodynamics, ablation, heat transfer, and stress. Author

A93-30845
FINITE ELEMENT ANALYSIS OF LARGE-AMPLITUDE PANEL FLUTTER OF THIN LAMINATES
IAIN R. DIXON and CHUH MEI (Old Dominion Univ., Norfolk, VA) AIAA Journal (ISSN 0001-1452) vol. 31, no. 4 April 1993 p. 701-707. Previously cited in issue 12, p. 1997, Accession no. A91-32030 refs
Copyright

A93-30936#
DESIGNING RELIABILITY INTO MULTICHIP MODULES - AN INTELLIGENT MODELING APPROACH
DOUGLAS J. HOLZHAUER, DALE W. RICHARDS, PETER J. ROCCI, MARK J. STOKLOSA, PAUL S. YAWORSKY (USAF, Rome Lab., Griffiss AFB, NY), IAN R. GROSSE, and DANIEL D. CORKILL (Massachusetts Univ., Amherst) Feb. 1993 6 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1022)

A new methodology for performing thermal reliability analysis of multichip modules (MCM) is described. This new approach supports the reliability assessment of multichip module technology during the design phase by integrating traditional thermal analysis techniques, such as Finite Element Analysis (FEA), with artificial intelligence techniques. Specifically, the use of object-oriented programming, blackboard architecture, and knowledge sources (based on expert systems) allow the computer to perform lower level reasoning associated with the development of the finite element mesh. The use of this software, called Intelligent Multichip Module Analyzer (IMCMA), will result in a great reduction in the amount of time required to model and to perform thermal analysis of multichip modules. This in turn will allow the analysis to be integrated with the design process so that reliability assessment can be accomplished when it can best affect the design. Author

A93-30944#
STRUCTURAL DESIGN SPACE DEFINITION USING NEURAL NETWORKS AND A REDUCED KNOWLEDGE BASE
S. M. BATILL and R. A. SWIFT (Notre Dame Univ., IN) Feb. 1993 9 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Research supported by USAF refs
(AIAA PAPER 93-1034) Copyright

A neural network application to preliminary structural design is presented. This application involved the recursive training of a neural network in order to represent the design space of a structural concept using the minimum amount of detailed, and expensive, information. The resulting neural network was used to determine the influence of various configurational design variables on structural performance. Minimizing the required neural network training data is an important goal. This approach was applied to two design problems; the configurational design of a 10 bar truss for minimum weight, and the configurational design of a four spar light aircraft wing-box with weight, displacement, and natural frequency as the constraints/objective functions. In both examples, design information obtained from a set of fully-stressed designs was used to train the neural network representation of the design space. The ability of the neural network to accurately and effectively predict structural behavior is demonstrated. Author

A93-31026#
THE USE OF VIBRATION ISOLATORS TO REDUCE AEROSPACE SUBSYSTEM WEIGHT AND COST
J. B. DONOVAN and E. L. AUSLANDER (Lord Corp., Aerospace Products Div., Erie, PA) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1146) Copyright

An industry-wide strategy for the 1990's should be to design vibration isolators into aerospace mechanical subsystems during the initial design phase in order to reduce subsystem weight and cost. This paper illustrates the vibration isolation system's effectiveness in reducing stress levels in the subsystem to minimize subsystem weight by using less material and reduce subsystem cost by using less expensive materials. This is done while maintaining acceptable stress levels, and thus, an acceptable endurance life for the subsystem. An example of weight and cost reduction is given for a two-degree-of-freedom system consisting of a simply-supported beam. This example shows 42 percent and 15 percent reductions in weight and cost respectively. Finally, an example of a multiple-degree-of-freedom system is given consisting of a typical aerospace structure and employing FEM. These examples lead to design guidelines that aerospace subsystem designers and electronic packaging engineers can use to reduce weight and cost. Author

A93-31126
PROGRESSIVE FABRICATION PROCESSES IN AIRCRAFT-ENGINE PRODUCTION [PROGRESSIVNYE TEKHNOLOGICHESKIE PROTSESSY V AVIADVIGATELESTROENII]
V. V. VOROBEI, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 78 p. In Russian.
Copyright

The papers presented in this volume provide an overview of some advanced fabrication processes that are currently used in the production of aircraft engines. In particular, attention is given to an analytical study of the bulk-abrasive machining of screw-shaped parts, exoemission diagnostics of the surface layer

of gas turbine engine components following ion treatment, and calculation of the profile of a film deposited in a magnetron spraying system of the plane annular type. The discussion also covers an automated method for monitoring the shape and position of parts of complex configurations, automated measurement of shape deviations, and problems in the hardware and software support of computerized balancing. (For individual items see A93-31127 to A93-31139) V.L.

A93-31128
REGIONS OF OPTIMAL APPLICABILITY OF CUTTING TOOLS OF SUPERHARD MATERIALS IN THE MACHINING OF REFRACTORY METALS [OBLAST' RATSIONAL'NOGO PRIMENENIIA LEZVIINYKH INSTRUMENTOV IZ STM PRI OBRABOTKE TUGOPLAVKIKH METALLOV]
V. N. KALENOV and V. I. ORLOV *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 7-10. In Russian. refs
Copyright
The machinability characteristics of refractory metals, such as tungsten, molybdenum, tantalum, niobium, and their alloys, are examined with reference to data in the literature and experimental results. The objective is to determine the optimal applicability regions of cutters made of superhard materials (SHM). An analysis of the available data suggests that the use of SHM tools, as compared with hard-alloy tools, is efficient above a certain hardness threshold of the machined material. In particular, the use of SHM tools is recommended for tungsten and tungsten-based alloys. V.L.

A93-31133
ADEQUACY OF A MATHEMATICAL MODEL OF THE ASSEMBLY OF AIRCRAFT ENGINE COMPONENTS [ADEKVATNOST' MATEMATICHESKOI MODELI SBORKI UZLOV DLA]
I. A. KARZOV and M. M. DEMIN *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 34-41. In Russian. refs
Copyright
The specific characteristics of mathematical models of assembly as a particular case of technological mathematical models are briefly examined, and the importance of the adequacy of the boundary values of a model is emphasized. Results of a generalized analysis of a statistical regression model of assembly are presented. Three specific problems are considered as an example. V.L.

A93-31139
PROBLEMS OF THE HARDWARE AND SOFTWARE SUPPORT OF THE COMPUTERIZED BALANCING PROCESS [ZADACHI APPARATNOGO I PROGRAMMNOGO OBESPECHENIIA KOMP'IUTERNOI TEKHNOLOGII BALANSIROVKI]
A. G. PUSHKAREV and V. V. TIKHOMIROV *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 71-74. In Russian. refs
Copyright
The use of computer-aided balancing procedures for improving the efficiency and accuracy of the balancing of flexible and quasi-flexible rotors is discussed. The principal stages of the computerized balancing process are briefly characterized, and the advantages of the new methods over the traditional technology are demonstrated. The discussion also covers the use of sequential analysis methods and the general architecture of a flexible balancing module. V.L.

A93-31152
NONLINEAR DEFORMATION MECHANICS OF MULTILAYER ELEMENTS OF AIRCRAFT TRANSPARENCIES - A METHOD OF ACCOUNTING FOR THE COMPLIANCE OF CONTOUR ATTACHMENT ELEMENTS [NELINEINAIA MEKHANIKA DEFORMIROVANIIA MNOGOSLOINYKH ELEMENTOV OSTEKLENII - METODIKA UCHETA PODATLIVOSTI ELEMENTOV KONTURNOGO KREPLENIIA]
A. I. KALASHNIKOV, V. N. PAIMUSHIN, and V. A. FIRSOV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 5-10. In Russian. refs
Copyright
By using a general variational principle, the static and thermoelastic problem for multilayer shells is stated and solved in an approximate manner with allowance for the compliance of their attachment to the aircraft frame. In accordance with the approach used here, the contact reactive forces acting on the shell from the bases are replaced by a statically equivalent system of contour loads applied to the boundary section. A closed system of resolvent equations is obtained which describes the mechanics of interaction of multilayer shells with deformed bases. V.L.

A93-31157
EXPERIENCE OF THE FABRICATION AND OPERATION OF SMALL REGENERATIVE GAS TURBINE ENGINES [OPYT SOZDANIIA I EKSPLUATATSII MALORAZMERNYKH REGENERATIVNYKH GAZOTURBINNYKH DVIGATELEI]
F. E. KAL'NITSKII, V. I. LUK'IANOV, and V. T. MAKHANEV Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 27-33. In Russian. refs
Copyright
The development of small regenerative gas turbine engines at the N. Novgorod Automotive Plant in Russia is discussed. The designs and performance characteristics of two typical turbine engines representing the first and second generations are examined. The technical and ecological advantages of such engines are demonstrated. V.L.

A93-31184
HYDRODYNAMIC LOAD ON AN OSCILLATING CYLINDRICAL SHELL WALL [O GIDRODINAMICHESKOI NAGRUZKE NA KOLEBLIUSHCHEISIA STENKE TSILINDRICHESKOI OBOLOCHKI]
V. V. DITKIN (RAN, Vychislitel'nyi Tsentr, Moscow, Russia) Rossiiskaia Akademiia Nauk, Doklady (ISSN 0869-5652) vol. 327, no. 2 1992 p. 196-200. In Russian. refs
Copyright
An approach to hydrodynamic (aerodynamic) load calculation for a thin cylindrical shell is proposed. In accordance with this approach, the stability analysis for a thin cylindrical shell, with flow of an inviscid compressible gas inside the shell, is reduced to solving the problem of the combined stability of the gas-shell system. V.L.

A93-31201
CURRENT PROBLEMS IN THE DYNAMICS AND DESIGN OF MECHANISMS AND MACHINES [SOVREMENNYE PROBLEMY DINAMIKI I KONSTRUIROVANIIA MEKHANIZMOV I MASHIN]
V. N. KESTEL'MAN, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 68 p. In Russian.
Copyright
The papers contained in this volume deal with possible ways of improving the dynamic and structural properties of machines and mechanisms and also with problems associated with the design of aircraft equipment. Topics discussed include estimation of the stressed state of a model of an orbital film structure, a study of the operation of an aerodynamic angle transducer in flow of a hot gas, calculation of the efficiency of aircraft gear drives, and dynamic accuracy of a controlled manipulator. Papers are also presented on optimal synthesis of mechanical systems with variable properties, synthesis of mechanisms using initial kinematic chains, and using shape memory materials in the design of machines

and mechanisms. (For individual items see A93-31202 to A93-31214) V.L.

A93-31204
A STUDY OF THE OPERATION OF AN AERODYNAMIC ANGLE TRANSDUCER IN FLOW OF A HOT GAS [ISSLEDOVANIE RABOTY DATCHIKA AERODINAMICHESKIKH UGLOV V POTOKE GORIACHEGO GAZA]
E. V. VASIL'EV, V. V. VOLGIN, and V. E. IVANOV *In* Current problems in the dynamics and design of mechanisms and machines Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 14-17. In Russian.
Copyright
The performance of an aerodynamic angle transducer was investigated experimentally in a 30 m/s flow of a gas heated to 400, 500, 600, and 700 C. The experiments were carried out with and without a protective shield made of a 0.5-mm-thick stainless foil and a 10-mm-thick asbestos plate. It is found that the highest temperature is reached in the first bearing unit; the maximum heating temperature (130 C) is reached with a flow temperature of 1500 C for the shielded transducer and 800 C for the unprotected transducer. V.L.

A93-31205
CALCULATION OF THE EFFICIENCY OF AIRCRAFT GEAR DRIVES [RASCHET KOEFFITSIENTOV POLEZNOGO DEISTVIIA ZUBCHATYKH PEREDACH AVIATSIONNYKH PRIVODOV]
B. I. SHATALOV *In* Current problems in the dynamics and design of mechanisms and machines Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 17-21. In Russian. refs
Copyright
Expressions are presented for determining the efficiency of helical, spur, and beveled gear drives. It is shown that losses in the gearing increase significantly with the decreasing number of teeth; the efficiency of external gears is less than that of internal gears. A formula for determining friction losses is included. V.L.

A93-31208
NUMERICAL STUDY OF THE DYNAMICS OF AXISYMMETRIC STRUCTURES INTERACTING WITH FLOW OF A LIQUID [CHISLENNOE ISSLEDOVANIE DINAMIKI OSESIMMETRICHNYKH KONSTRUKTSII, VZAIMODEISTVUIUSHCHIKH S POTOKOM ZHIDKOSTI]
M. I. MARTIROSOV and V. M. POLIANSKII *In* Current problems in the dynamics and design of mechanisms and machines Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 28-32. In Russian. refs
Copyright
The paper is concerned with problems of the dynamic interaction of elastic axisymmetric structures with flow of an ideal incompressible liquid. One of the problems examined deals with the dynamics of the entry of axisymmetric structures through a plane boundary into a half-space containing a liquid. Another problem concerns the dynamic behavior of structures consisting of thin elastic shells of revolution, coupled with a rigid cylindrical mass, during the vertical and oblique exit from a liquid filling the lower half-space. Numerical methods that are used to solve these problems are discussed. V.L.

A93-31213
A DRIVE BASED ON AN ELEMENT MADE OF A THERMOMECHANICAL MEMORY MATERIAL [PRIVOD NA OSNOVE ELEMENTA IZ MATERIALA S TERMOMEKHANICHESKOI PAMIAT'IU]
O. I. KRAKHIN, I. N. DUBOVIK, and IU. A. ROZARENOVA *In* Current problems in the dynamics and design of mechanisms and machines Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 54-57. In Russian. refs
Copyright
The advantages of using drives with active elements made of thermomechanical memory materials in aircraft structures are briefly reviewed. The choice of a particular type of active element based on a thermomechanical memory material is shown to depend on the specific operating conditions of the drive. The design of a rotary drive with an active element of TN-1 alloy is examined as an example. V.L.

A93-31246
STATIC AEROELASTICITY AND FREE VIBRATION BEHAVIOR OF ADAPTIVE AIRCRAFT WING STRUCTURES MODELLED AS COMPOSITE THIN-WALLED BEAMS
LIVIU LIBRESCU, CRAIG A. ROGERS, and OHSEOP SONG (Virginia Polytechnic Inst. and State Univ., Blacksburg) *In* Joint Japan/U.S. Conference on Adaptive Structures, 2nd, Nagoya, Japan, Nov. 12-14, 1991, Collection of Papers Lancaster, PA Technomic Publishing Co., Inc. 1992 p. 461-478. refs
Copyright
Two problems associated with the behavior of aircraft wing structures incorporating piezoelectric effects are investigated. These problems concern the free vibration and the static aeroelastic behavior of airplane wings modelled as thin-walled beams. The pertinent equations of adaptive thin-walled beams are established via a Hamilton variational principle extended to the case of a linear 3D piezoelectric medium. The results obtained reveal the great potentialities of applying adaptive technology to the control of the behavior of wing structures from aeroelastic and vibrational points of view. Author

A93-31282
AIR FORCE REQUIREMENTS FOR NDE OF COMPOSITE MATERIALS
T. M. CORDELL and P. K. BHAGAT (USAF, Wright Lab., Wright-Patterson AFB, OH) *In* Enhancing analysis techniques for composite materials; Proceedings of the Symposium, ASME Winter Annual Meeting, Atlanta, GA, Dec. 1-6, 1991 New York American Society of Mechanical Engineers 1991 p. 67-75. refs
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The usage of composite materials has increased and continues to grow in advanced and sophisticated weapon systems. The complexity of structures, and the need for rapid inspection and assessment of systems require further development of existing inspection methods to provide the accuracy and reliability desired. Because of the inherently anisotropic and sometimes nonuniform layered nature of composites, detection and interpretation of defects in operational systems is difficult. Further compounding the inspection problem is the growing requirement to assess the integrity of large structures, and to acquire and interpret large data sets in near real time. This paper examines various aspects of composite development, manufacture, assembly, and inspection issues as they relate to Air Force needs and requirements. Current and future initiatives are detailed and an attempt is made to highlight the inadequacies of current inspection procedures: their reliability and sensitivity to discriminate among various defect states. Author

A93-31324
THE THERMAL STRESSES INDUCED IN RECTANGULAR COMPOSITE PLATES
TSENG-HSIANG CHENG (Taiwan Power Co., Taiwan) Chinese Society of Mechanical Engineers, Journal (ISSN 0257-9731) vol. 13, no. 6 Dec. 1992 p. 483-492. refs
This paper gives a general procedure for obtaining the thermal stresses induced in a laminated composite plate. Applying the principle of minimum potential energy, this method provides an excellent alternative to one-dimensional solutions. In addition, the plots for the trend of non-dimensionalized thermal stresses also give a good explanation for the induced thermal stresses of the composite plates. Author

A93-31340
TMF DESIGN CONSIDERATIONS IN TURBINE AIRFOILS OF ADVANCED TURBINE ENGINES
C. G. DATE (Allied-Signal Aerospace Co., Garrett Engine Div.,

Phoenix, AZ), S. Y. ZAMRIK (Pennsylvania State Univ., University Park), J. H. ADAMS, and N. E. FRANI (Allied-Signal Aerospace Co., Garrett Engine Div., Phoenix, AZ) *In* Creep-fatigue interaction at high temperature; Proceedings of the Symposium, 112th ASME Winter Annual Meeting, Atlanta, GA, Dec. 1-6, 1991 New York American Society of Mechanical Engineers 1991 p. 59-64. refs
Copyright

A review of thermal-mechanicalfatigue (TMF) in advanced turbine engines is presented. The review includes examples of typical thermal-mechnical loadings encountered in the design of hot section blades and vanes. Specific issues related to TMF behavior are presented and the associated impact on component life analysis and design is discussed. Author

A93-31418
A BI-DIRECTIONAL GAS FACE SEAL - EXPERIENCE UNDER TEST CONDITIONS AND IN PRACTICAL USE
J. NOSOWICZ and D. ZEUS (F. Burgmann Dichtungswerke GmbH & Co., Wolfratshausen, Germany) Lubrication Engineering (ISSN 0024-7154) vol. 49, no. 3 March 1993 p. 217-221. refs
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Tests showed that the operating behavior of uni-directional and bi-directional gas face seals of identical size is quite different. The leakage rate of a bi-directional gas face seal is smaller than that of a uni-directional gas face seal, and the temperature development is larger. These differences are the result of a smaller gap between the seal face and the counterface in a bi-directional gas face seal. To realize the operating behavior and therefore the reliability of a uni-directional gas face seal, a special bi-directional gas face seal was developed. The design of this seal, test results, and experience of the turbocompressor performance test are presented and discussed. Author

A93-31424
REDUCTION OF COMPOSITE PANEL INITIAL CURVATURE BY TOOL COMPENSATION
STEVEN P. RENZE and DAVID H. LAANANEN (Arizona State Univ., Tempe) Journal of Thermoplastic Composite Materials (ISSN 0892-7057) vol. 5, no. 4 Oct. 1992 p. 287-303. Research supported by ICI Composite Structures refs
Copyright

Integrally forming stiffeners in a panel provides an economically favorable means of manufacturing stiffened composite panels for use in aerospace structures. However, the initial curvature that is introduced into the flat panel region between the stiffeners can significantly reduce the panel's resistance to buckling. The influence of initial curvature on buckling due to uniaxial compression and to uniform shear is investigated. Finite element analysis is used to predict the initial curvature, and analytical results are used in compensation of the forming tool to reduce the initial curvature. Predictions are compared with experimental buckling results for panels fabricated using the compensated tool. Author

A93-31426
CURRENT TRENDS IN HEAT TRANSFER COMPUTATIONS
A. F. EMERY, R. J. COCHRAN (Washington Univ., Seattle), and D. W. PEPPER (Applied Research Projects, Inc., Moorpark, CA) *Journal of Thermophysics and Heat Transfer* (ISSN 0887-8722) vol. 7, no. 2 Apr.-June 1993 p. 193-212. Previously cited in issue 07, p. 1034, Accession no. A91-21384 refs
Copyright

A93-31431* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CURRENT DISTRIBUTION IN THE CATHODE AREA OF AN ARCJET
P. DURGAPAL (NASA, Ames Research Center, Moffett Field, CA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 7, no. 2 Apr.-June 1993 p. 241-250. Previously cited in issue 18, p. 3073, Accession no. A91-43449 refs
(Contract NCC2-688)
Copyright

A93-31434* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THEORY OF RADIATION FROM LOW VELOCITY SHOCK HEATED AIR
D. A. LEVIN, R. T. LODA (Inst. for Defense Analyses, Alexandria, VA), G. V. CANDLER (North Carolina State Univ., Raleigh), and C. PARK (NASA, Ames Research Center, Moffett Field, CA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 7, no. 2 Apr.-June 1993 p. 269-276. Previously cited in issue 06, p. 811, Accession no. A90-19697 Research supported by SDIO refs
(Contract MDA903-89-C-0003)
Copyright

A93-31436 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLOWFIELD COUPLED EXCITATION AND RADIATION MODEL FOR NONEQUILIBRIUM REACTING FLOWS
THOMAS A. GALLY, LELAND A. CARLSON, and DEREK GREEN (Texas A & M Univ., College Station) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 7, no. 2 Apr.-June 1993 p. 285-293. Previously cited in issue 18, p. 3198, Accession no. A91-43532 refs
(Contract NAG1-1003)
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A93-31448
INVESTIGATION OF THE TEMPORAL THERMAL PERFORMANCE OF THE WHEEL OUTBOARD OF AN AIRCRAFT
C. P. DESAI and K. VAFAI (Ohio State Univ., Columbus) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722) vol. 7, no. 2 Apr.-June 1993 p. 377-384. Research supported by BF Goodrich and Ohio Supercomputer Center refs
Copyright

Three-dimensional transient natural convection flow and heat transfer around the wheel outboard portion of an aircraft brake housing was investigated. The wheel outboard is modeled as an annular cavity with one end open to the ambient surroundings. The temporal development of the flow and temperature fields and its effect on the thermal performance of the brake housing outboard is discussed. The transient results are presented here by means of the velocity and temperature fields and the average Nusselt numbers over the different surfaces of the geometry. The effect of Rayleigh number and length of the inner cylinder on the thermal performance of the wheel outboard are also discussed. Author

A93-31453
CLOSED LOOP FIBER OPTIC GYRO TRIAD
HANNES J. BUESCHELBERGER and MANFRED KEMMLER (LITEF GmbH, Freiburg im Breisgau, Germany) *In* Fiber Optic Gyros: 15th Anniversary Conference, Boston, MA, Sept. 4-6, 1991, Proceedings Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 89-97. refs
Copyright

The LFS-90 FOG system for flight-control applications presently discussed, in which three gyros are combined in a 'triad' configuration, operates on the basis of digital closed-loop electronics and uses a digital signal processor for error compensation. The LFS-90 unit is able to communicate with a flight control system by a variety of commands, and is ideal in cases where volume restraints are a paramount consideration; system volume is only 0.56 liters. O.C.

A93-31455
DRIFT REDUCTION IN AN OPTICAL PASSIVE RING-RESONATOR GYRO
KAZUO HOTATE and KOICHI TAKIGUCHI (Tokyo Univ., Japan) *In* Fiber Optic Gyros: 15th Anniversary Conference, Boston, MA, Sept. 4-6, 1991, Proceedings Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 116-127. refs
Copyright

A test program has been conducted with a view to defining methods for reducing the drift of optical passive ring-resonator gyros (OPRG). Attention is given to such noise sources and noise-reduction techniques as Rayleigh backscattering, polarization fluctuation, and fiber-resonator optical Kerr effect. A novel, partial digital feedback scheme is defined for preventing the OPRG from lapsing into large drift, due to thermal expansion of the resonator. O.C.

A93-31495
DEVELOPING FATIGUE RESISTANT JET TRANSPORT STRUCTURE
ROY T. WATANABE (Boeing Commercial Airplane Group, Seattle, WA) ASTM Standardization News (ISSN 0090-1210) vol. 21, no. 3 March 1993 p. 30-33. refs
Copyright

The state-of-the-art in fatigue-resistant design practices for transport aircraft are surveyed, emphasizing the selection of materials that inherently possess long fatigue lives, high fracture toughness, and corrosion resistance. Designers must be especially cognizant of the fact that these properties are in some instances inversely related to static strength. It is noted that most major manufacturers rely heavily on proprietary test specimens and procedures, leading to substantial industry-wide duplication in design/verification criteria, the identification of operating loads, and standard specimens. O.C.

A93-31607
APPLICATION OF THE HYBRID FINITE ELEMENT METHOD TO AIRCRAFT REPAIRS
PIN TONG (Hong Kong Univ. of Science and Technology, Hong Kong), ROBERT GREIF (DOT, Transportation Systems Center, Cambridge; Tufts Univ., Medford, MA), and LI CHEN (Tufts Univ., Medford, MA) *In* Fracture mechanics; Proceedings of the 22nd National Symposium, Atlanta, GA, June 26-28, 1990. Vol. 2 Philadelphia, PA American Society for Testing and Materials 1992 p. 154-169. Research supported by FAA refs
Copyright

A hybrid finite element approach is presented for the analysis of cracked panels with riveted doublers in airframe structures. The method uses the super element developed by Tong to model the cracked panel with rivet holes, springs to model the rivets, and regular finite elements to model the doubler. The super element accurately models the crack and rivet holes of the skin while the regular finite element method provides the versatility to take into account the variety of doubler designs. Numerical results are presented to demonstrate the efficiency and accuracy of this approach, and to compare different doubler designs. Author

A93-31631
CIE 1991 INTERNATIONAL CONFERENCE ON RADAR (CICR-91), BEIJING, CHINA, OCT. 22-24, 1991, PROCEEDINGS
NENGJING LI, ED. (Chinese Inst. of Electronics, Beijing, China) and SIYONG ZHOU, ED. (Beijing Inst. of Technology, China) Beijing International Academic Publishers 1991 706 p. For individual items see A93-31632 to A93-31768
(ISBN 7-80003-151-9) Copyright

The present volume on radar discusses a modern perspective on radar signal processing, a historical survey on airborne early warning, array pattern and target parameter estimation for distributed array radar, and a review of surface surveillance radars. Attention is given to new concepts of spaceborne surveillance radar, UHF Doppler wind-profiling radar and performance analyses, a low-angle tracking method for tactical monopulse radars, and a laser radar for the detection of cables and other hazardous obstacles. Topics addressed include real-time multifunction radar simulation, new estimators of probability tails for radar application, an advanced low-altitude search radar, and beam spacing optimization for a surveillance phased array radar. Also discussed are broadband aspects of a triple-patch antenna as an array element, an effective way to analyze broadband radomes, selective devices on magnetostatic surface waves, and the orthogonality algorithm in adaptive arrays. AIAA

A93-31678
HIGH TECHNOLOGY MAGNETRON TRANSMITTERS FOR ATC SYSTEMS INTO THE 21ST CENTURY
A. J. CHEESEWRIGHT (Marconi Radar Systems, Chelmsford, United Kingdom) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 231-234.
Copyright

The effect of magnetron transmitter design on overall system performance is examined. System requirements for modern ATC radars, transmitter technologies for TMA/Approach radars, the magnetron environment, and magnetron performance relative to linear beam transmitters are discussed. It is shown that when modern magnetrons are properly engineered into a TMA/Approach radar system, they produce a system stability for MTI systems which is superior to that of a TWT system. In terms of price, the magnetron system is better able to support high availability than linear beam tube equivalents, by virtue of its dual-channel configuration. Engineering designs of magnetron transmitters can easily be made to allow retrospective fitment of emerging improved magnetrons and their modulators. AIAA

A93-31743
ADAPTIVE MTI SYSTEM FOR STAGGERED PRF RADARS
ANDRZEJ WOJTKIEWICZ, KRZYSZTOF KULPA, MICHAL TUSZYNSKI, and JACEK MISIUREWICZ (Warsaw Univ. of Technology, Poland) *In* CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct. 22-24, 1991, Proceedings Beijing International Academic Publishers 1991 p. 524-527. refs
Copyright

This paper describes adaptive MTI system for weather and ground clutter rejection, which will be used in a staggered PRF (pulse repetition frequency) ATC radar. The system presented here consists of two blocks: filter block which contains a cascade connection of an adaptive ground clutter MTI filter and a weather clutter MTI filter with periodically varying complex coefficients and control block containing clutter parameters' map and clutter parameters' estimation unit which estimates power, mean Doppler frequency and bandwidth of clutter. Author

A93-31769
HEAT TRANSFER PECULIARITIES IN SUPERSONIC FLOWS
V. IA. BOROVOI, V. N. BRAZHKO, G. I. MAIKAPAR, A. S. SKURATOV, and I. V. STRUMINSKAIA (TsAGI, Moscow, Russia) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 969-977. refs
Copyright

A method of heat transfer and gas flow investigation based on the application of thermal sensitive coatings or thermocouple sensors and various visualization techniques is described. The thermal sensitive coatings and visualization reveal heat transfer peculiarities, and the complex nature of the method contributes to understanding the processes and generalization of quantitative results. Data concerning heat transfer on the leeward side of a blunt cone in the regions of the shock-wave boundary layer and bow wave interaction, in gaps and cavities of the orbiter's thermal insulation, and in the vicinity of them, are presented. Author

A93-31936
FOUNTAIN FLOWS PRODUCED BY MULTIJET IMPINGEMENT ON A GROUND PLANE
J. M. M. BARATA (Inst. Superior Tecnico, Lisbon, Portugal) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 50-56. AIAA, Fluid Dynamics, Plasma Dynamics and Lasers Conference, 22nd, Honolulu, HI, June 24-26, 1991, AIAA Paper 91-1806. Previously cited in issue 17, p. 2940, Accession no. A91-42602 refs
Copyright

A93-31945
SUPERSONIC FLUTTER OF LAMINATED THIN PLATES WITH THERMAL EFFECTS

D. G. LIAW (Sverdrup Technology, Inc., Brook Park, OH) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 105-111. refs
Copyright

A 48 degree-of-freedom rectangular laminated thin plate finite element including the effects of thermal and aerodynamic loadings is formulated to study the buckling and supersonic flutter characteristics of thin plate structures. Interactive effects between the critical temperature difference and critical aerodynamic pressure for the plates are also studied. The element formulation is based on the classical lamination theory. The aerodynamic pressure due to supersonic potential flow is described by a two-dimensional steady supersonic theory. The element formulation and solution procedure are evaluated by comparing results of three examples with existing alternative solutions. The practical applicability is demonstrated by performing buckling and supersonic flutter analyses of laminated thin plates under various types of temperature distributions. Based on the numerical results, the effects of aspect ratio, ratio of thermal expansion coefficients, fiber orientation, type of temperature distribution, and flow angularity on these examples are discussed. Author

A93-31967
LASER-INITIATED CONICAL DETONATION WAVE FOR SUPERSONIC COMBUSTION. II
F. FENDELL, J. MITCHELL, R. MCGREGOR, and M. SHEFFIELD (TRW Space and Technology Group, Redondo Beach, CA) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 182-190. AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992, AIAA Paper 92-0088. Previously cited in issue 07, p. 1052, Accession no. A92-22195 refs
(Contract F49620-90-C-0070)
Copyright

A93-31982* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODAL SIMULATION OF GEAR BOX VIBRATION WITH EXPERIMENTAL CORRELATION
F. K. CHOY, Y. F. RUAN (Akron Univ., OH), J. J. ZAKRAJSEK, and F. B. OSWALD (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 301-306. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992, AIAA Paper 92-3494. Previously cited in issue 23, p. 4157, Accession no. A92-54036 refs
Copyright

A93-31985
NUMERICAL SIMULATIONS OF GAS TURBINE COMBUSTOR FLOWS
D. LEE, C. L. YEH (National Cheng Kung Univ., Tainan, Taiwan), Y. M. TSUEI, and J. CHOU (Chung Shan Inst. of Science and Technology, Taipei, Taiwan) Journal of Propulsion and Power (ISSN 0748-4658) vol. 9, no. 2 Mar.-Apr. 1993 p. 322-328. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 26th, Orlando, FL, July 16-18, 1990, AIAA Paper 90-2305. Previously cited in issue 18, p. 2889, Accession no. A90-42116 refs
(Contract NSC-78-0210-D006-01; NSC-80-0210-E006-05)
Copyright

A93-32043
CALIBRATION OF A LYMAN-ALPHA SENSOR TO MEASURE IN-CLOUD TEMPERATURE AND CLEAR-AIR DEWPOINT TEMPERATURE
JORGEN B. JENSEN (CSIRO, Div. of Atmospheric Research, Aspendale, Australia) and GRACIELA B. RAGA (Atmospheric Environment Service, Downsview, Canada) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572) vol. 10, no. 1 Feb. 1993 p. 15-26. refs
Copyright

A new calibration technique for a simple Lyman-alpha sensor is described. In contrast to other methods, the technique incorporates absorption due to both water vapor and oxygen and is valid over a large altitude range. The performance of the sensor during the 1985 Joint Hawaii Warm Rain Project is discussed. The wetting characteristics of the Rosemount and reverse-flow temperature sensors are also discussed. AIAA

A93-32058
A FLOW VISUALIZATION STUDY OF THE FLOW IN A 2D ARRAY OF FINS
S. BROKMAN (Israel Electric Corp., Research and Development Div., Haifa) and D. LEVIN (Technion - Israel Inst. of Technology, Haifa) Experiments in Fluids (ISSN 0723-4864) vol. 14, no. 4 Feb. 1993 p. 241-245. refs
Copyright

A study of the flow field in a 2 D arrangement of fins was carried out by means of flow visualization in a vertical water tunnel. A similar arrangement of fins had been tested as a conceptual heat sink, and the heat transfer measurement showed a dependence of the heat transfer qualities on the geometrical parameters of the fin's array. The current study examines the complex flow field structure in order to obtain a better understanding of the convection process. The model is built of several series of fins, generating a multi-cell structure. The investigation included a systematic variation of the fins' chord and inclination angle, as well as the flow velocity. Two main flow structures were observed. In the first one, the flow separates from the leading edge of each fin. Due to the influence of its neighboring fins, the flow re-attaches to the fin, creating a closed separation zone. A vortex fills this separation zone. The main flow accelerates in the passage that is created between the separation bubble and the neighboring fin. In the second flow structure, the flow separates from both leading and trailing edges of each fin. The separation is in alternating order and generates a nonsteady pair of vortices. This separation pattern is similar to that of a single plate at high angle of attack, and the effect of the neighboring fins is only to narrow the wake. The pressure drop across the model was measured and correlated to a single nondimensional variable on a single curve. Author

A93-32157
THE EVAPORATION LENGTH OF A KEROSENE SPRAY JET IN SUPERSONIC FLOW [DLINA ISPARENIIA STRUI RASPYLENNOGO KEROSINA V SVERKHZVUKOVOM POTOKE]
V. N. AVRASHKOV and T. V. KAZAKOVA *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 12-15. In Russian. refs
Copyright

A method for estimating the evaporation length of an individual kerosene spray jet in a cross stream of heated air is proposed which uses an empirical relation. The relation is obtained by analyzing experimental data and identifying those jet and flow parameters that have the strongest effect on the spray jet evaporation length. The method proposed here can be used for engineering estimates. AIAA

A93-32171
MATHEMATICAL MODELING OF A HEAT EXCHANGER IN THE SYSTEM OF A COMBINATION ENGINE [MATEMATICHESKOE MODELIROVANIE TEPLOOBMENNIKA V SISTEME KOMBINIROVANNOGO DVIGATELIA]
V. I. BAKULEV, V. V. KOZLIAKOV, and I. V. KRAVCHENKO *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 86-91. In Russian.
Copyright

A mathematical model for heat exchangers is developed whereby the heat transfer process is described in terms of a small number of dimensionless parameters, including heat exchanger efficiency, number of heat transfer units, and the ratio of aqueous heat transfer agent equivalents. A modular computer program is also developed which makes it possible to calculate heat exchangers of practically any type. The mathematical model

and the program can be used for calculating the characteristics of combination engines that incorporate heat exchangers. AIAA

A93-32187
CREEP OF A THIN-WALLED CYLINDRICAL SHELL REINFORCED BY STIFFNESS RIBS [POLZUCHEST' TONKOSTENNOI TSILINDRICHESKOI OBOLOCHKI, PODKREPLENNOI REBRAMI ZHESTKOSTI]
I. I. TRAPEZIN and A. S. DEMIDOV *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 18-23. In Russian. refs
Copyright

The creep behavior of a thin-walled cylindrical shell reinforced by circular ribs is described in terms of a differential equation. By using the finite difference equivalents of the derivatives, the problem is reduced to that of solving a system of nonlinear equations. Another solution is also described which combines the finite difference method with the method of successive approximations. The deflections of a shell (10 x 0.5 x 5 mm) of a hypothetical alloy are examined as an example. AIAA

A93-32190
DETERMINATION OF NONSTATIONARY TEMPERATURE FIELDS IN A PUMP TURBINE BLADE (THREE-DIMENSIONAL PROBLEM) [OPREDELENIE NESTATSIONARNYKH TEMPERATURNYKH POLEI V LOPATKE TURBINY NASOSNOGO AGREGATA /OB'EMNAIA ZADACHA/]
S. N. VORONIN and F. P. ZAKHARCHENKO *In* Vibrations, deformations, and strength of flight vehicle engine structures Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 36-41. In Russian. refs
Copyright

A calculation scheme is presented for determining nonstationary temperature fields in turbine blades, and results of calculations are presented for a pump turbine blade of EI-437B alloy. For the specific case considered, it is found that the temperature differential along the middle line between the edges and the center of the blade during the warm-up stage can be as high as 300 C. The temperature differential over the blade thickness is negligible. Temperature distribution in the middle section of blade can be obtained by solving a plane problem. AIAA

A93-32239
FLOW FIELD ANALYSIS, DEPICTION, AND INTERPRETATION - WORK STATIONS ARE INDISPENSABLE TOOLS IN NUMERICAL FLOW SIMULATIONS [STROEMUNGSFELDER ANALYSIEREN, DARSTELLEN UND INTERPRETIEREN - WORKSTATIONS SIND UNERSETZLICHE WERKZEUGE IN DER NUMERISCHEN STROEMUNGSSIMULATION]
HEINRICH VOLLMERS (DLR, Inst. fuer Theoretische Stroemungsmechanik, Goettingen, Germany) DLR-Nachrichten (ISSN 0937-0420) no. 70 Feb. 1993 p. 2-8. In German.
Copyright

The central role of work stations in numerical flow simulations is highlighted. The use of work stations in the analysis and depiction of eddy flows around delta wings and NACA 0012 wing profiles is examined. AIAA

A93-32250
SELF-INDUCED FLOW AND HEAT TRANSFER IN A ROTATING TUBE
S. GILHAM (W.S. Atkins Science & Technology, Epsom, United Kingdom), P. C. IVEY (Cranfield Inst. of Technology, United Kingdom), and J. M. OWEN (Bath Univ., United Kingdom) International Journal of Heat and Fluid Flow (ISSN 0142-727X) vol. 14, no. 1 March 1993 p. 27-36. Research supported by SERC and Rolls-Royce, PLC refs
Copyright

Self-induced flow occurs when a tube, with one end open and the other sealed, is rotated about its axis: fluid flows along the axis towards the sealed end and returns in an annular layer on the cylindrical wall. Numerical solutions of the Navier-Stokes and energy equations have been obtained for laminar flow, and the Reynolds analogy has been used to provide theoretical correlations for the average Nusselt numbers on the end wall of the tube. Heat transfer measurements have been made in a rotating-tube rig, and the measured Nusselt numbers are, in the main, in good agreement with the computed values. Author

A93-32251
NEAR-EXIT FLOW-FIELD INVESTIGATION IN AN INDUCER INCLUDING LASER-DOPPLER VELOCIMETRY
J. H. G. HOWARD and A. ATIF (Waterloo Univ., Canada) International Journal of Heat and Fluid Flow (ISSN 0142-727X) vol. 14, no. 1 March 1993 p. 86-93. Research supported by NSERC, Ministry of Higher Education of Algeria, and Canadian International Development Agency refs
Copyright

The flow field was measured near the exit of an axial-flow spiral-inducer pump impeller at design and off-design conditions. Laser-Doppler velocimetry was employed to define the blade-to-blade velocity distribution inside and outside the rotating impeller passage near the trailing edge. The observed variation of velocity and flow angle revealed a strong secondary flow, of a double vortex form, at the design flow rate and a developing hub separation zone at lower flow rates. The observed rearrangement of the flow field between the closely spaced locations upstream and downstream of the trailing edge is believed to be linked to the developing recirculation zone. Distributed deviation angles are presented for the design flow rate and overall values for all flow rates. Author

A93-32411
FLUTTER SUPPRESSION OF THIN AIRFOILS USING ACTIVE ACOUSTIC EXCITATIONS
PONG-JEU LU and LI-JENG HUANG (National Cheng Kung Univ., Tainan, Taiwan) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2873-2881. refs
(Contract NSC-79-0401-E006-44)
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A theoretical analysis of the flutter suppression of oscillating thin airfoils using active acoustic excitation in incompressible flow is presented. Closed-form unsteady aerodynamic loads induced by a simple harmonic acoustic excitation on a typical section model are derived. The acoustic wave generator used in the present flutter suppression analysis is activated by a state feedback control law that particularly takes into account the relative phases between the sensed states and the acoustic excitations. The flutter boundaries of the typical section, with and without the acoustic excitations, are evaluated using both the V-g and root-locus methods. The results show that, although the acoustic wave is a weak flow perturbation per se, the induced aerodynamic loads can be large enough to be employed as the flutter control forces. The circulatory part that makes the flow satisfy the Kutta condition at the trailing edge contributes the most to the magnitude and phase of the acoustically induced airloads, in particular when the acoustic excitation position is placed close to the trailing edge. Parametric study reveals that both the phase of the feedback gain constant and the acoustic excitation position are critical for the present new flutter suppression technique. Author

A93-32412
APPLICATION OF ADAPTIVE TECHNOLOGY TO STATIC AEROELASTIC CONTROL OF WING STRUCTURES
O. SONG, L. LIBRESCU, and C. A. ROGERS (Virginia Polytechnic Inst. and State Univ., Blacksburg) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2882-2889. refs
Copyright

The static aeroelastic behavior of adaptive swept-forward wing structures modeled as thin-walled beams and incorporating piezoelectric effects is investigated. Based on the converse piezoelectric effect, the system of piezoelectric layers, embedded or bonded to the wing, yields control of both divergence instability and, in the subcritical speed range, of aeroelastic lift distribution. The numerical illustration reveals the ability of adaptive technology

to control the static aeroelastic response of swept-forward wings, and as a result, to fully exploit the advantages offered by such a wing configuration. Author

A93-32433
SUPERSONIC FLUTTER OF COMPOSITE SANDWICH PANELS
LE-CHUNG SHIAU (National Cheng Kung Univ., Tainan, Taiwan) AIAA Journal (ISSN 0001-1452) vol. 30, no. 12 Dec. 1992 p. 2987-2989. refs
Copyright

A flutter-motion equation is presently derived for a 2D composite sandwich panel considering the total lateral displacement of the plate as the sum of the displacement due to bending of the plate, and that which is due to shear deformation at the core. The effects of core thickness and stacking sequence of the faces on the flutter boundary of the plate are discussed; it is shown that the sandwich panel greatly improves the flutter boundary over that of a composite laminate panel, provided it has sufficient core thickness. AIAA

A93-32524
TOMOGRAPHIC RADAR IMAGING OF ROTATING STRUCTURES
GERALD G. FLISS (Michigan Environmental Research Inst., Ann Arbor) *In* Synthetic aperture radar; Proceedings of the Meeting, Los Angeles, CA, Jan. 20, 21, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 199-207. refs
Copyright

A high PRF rate single frequency instrumentation radar is used to generate two-dimensional images of rotating structures such as helicopter blades and hubs. The technique utilizes a tomographic backprojection reconstruction algorithm where Doppler spectra generate cross-range one-dimensional profiles of the rotating structure. A simplified computer generated scattering model is developed to show proof-of-concept and aid in developing the reconstruction algorithm. Author

A93-32623* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TRANSITION TO CHAOS IN AN OPEN UNFORCED 2D FLOW
THOMAS H. PULLIAM and JOHN A. VASTANO (NASA, Ames Research Center, Moffett Field, CA) Journal of Computational Physics (ISSN 0021-9991) vol. 105, no. 1 March 1993 p. 133-149. refs
Copyright

The present numerical study of unsteady, low Reynolds number flow past a 2D airfoil attempts to ascertain the bifurcation sequence leading from simple periodic to complex aperiodic flow with rising Reynolds number, as well as to characterize the degree of chaos present in the aperiodic flow and assess the role of numerics in the modification and control of the observed bifurcation scenario. The ARC2D Navier-Stokes code is used in an unsteady time-accurate mode for most of these computations. The system undergoes a period-doubling bifurcation to chaos as the Reynolds number is increased from 800 to 1600; its chaotic attractors are characterized by estimates of the fractal dimension and partial Liapunov exponent spectra. AIAA

A93-32632* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A MULTIDIMENSIONAL FLUX FUNCTION WITH APPLICATIONS TO THE EULER AND NAVIER-STOKES EQUATIONS
CHRISTOPHER L. RUMSEY (NASA, Langley Research Center, Hampton, VA), BRAM VAN LEER, and PHILIP L. ROE (Michigan Univ., Ann Arbor) Journal of Computational Physics (ISSN 0021-9991) vol. 105, no. 2 April 1993 p. 306-323. refs
Copyright

In the present grid-independent approximate Riemann solver for 2D and 3D flows that are governed by the Euler or Navier-Stokes equations, fluxes on grid faces are obtained by wave decomposition; the assumption of information-propagation in the velocity-difference directions leads to a more accurate resolution of shear and shock waves, when these are are oblique to the grid. The model, which yields significantly greater accuracy in both supersonic and subsonic first-order spatially accurate computations, describes the difference in states at each grid interface by the action of five waves. AIAA

A93-32718 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REDUCED-BASIS TECHNIQUE FOR EVALUATING THE SENSITIVITY COEFFICIENTS OF THE NONLINEAR TIRE RESPONSE
AHNED K. NOOR, JOHN A. TANNER, and JEANNE M. PETERS (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 370-376. AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 33rd, Dallas, TX, Apr. 13-15, 1992, Technical Papers. Pt. 2, p. 946-964. Previously cited in issue 13, p. 2208, Accession no. A92-34376 refs
(Contract NCCW-0011; NAG1-1180)
Copyright

A93-32723
IMPROVED BOUNDARY INTEGRAL METHOD FOR INVISCID BOUNDARY CONDITION APPLICATIONS
P. KOUMOUTSAKOS and A. LEONARD (California Inst. of Technology, Pasadena) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 401-404. refs
Copyright

The present computational treatment of the potential component of an unsteady, incompressible viscous flow around an arbitrary configuration, as well as the enforcement of the no-throughflow boundary condition, employs a solver to account for the convective and viscous part of the flow. This rigorous approach involves the application of the internal Neumann boundary condition, and is noted not to increase computational cost while improving the conditioning of the system by several orders of magnitude; this effect is especially pronounced as the number of panels increases. AIAA

A93-32743
VIBRATIONAL BEHAVIOR OF ADAPTIVE AIRCRAFT WING STRUCTURES MODELLED AS COMPOSITE THIN-WALLED BEAMS
O. SONG, L. LIBRESCU, and C. A. ROGERS (Virginia Polytechnic Inst. and State Univ., Blacksburg) *In* Smart structures and materials; Proceedings of the Symposium, 112th ASME Winter Annual Meeting, Atlanta, GA, Dec. 1-6, 1991 New York American Society of Mechanical Engineers 1991 p. 157-166. refs
Copyright

The vibrational behavior of cantilevered aircraft wings modeled as thin-walled beams and incorporating piezoelectric effects is investigated. Based on the direct and converse piezoelectric effects, the system of piezoelectric sensors and actuators conveniently located on the wing yield the control of its associated vertical and lateral bending eigenfrequencies. The possibility revealed by this study enabling one to increase adaptively the eigenfrequencies of thin-walled cantilevered beams could play a significant role in the control of the dynamic response and flutter of wing and rotor blade structures. Author

A93-32746
THE ROLE OF STRESS ANALYSIS IN THE DEVELOPMENT OF A SMART STRUCTURE
AMIYA K. CHATTERJEE and MARK N. WEST (Mission Research Corp., Survivable Structures and Technologies Div., Costa Mesa, CA) *In* Smart structures and materials; Proceedings of the Symposium, 112th ASME Winter Annual Meeting, Atlanta, GA, Dec. 1-6, 1991 New York American Society of Mechanical Engineers 1991 p. 203-208. refs
Copyright

'Smart' airframe structures promise to facilitate the automatic detection of damages, precluding catastrophic failure. Stress/strain

elevation due to embedded flaws in airframe primary structure composites, and the character of scattered elastodynamic fields from such flaws, must be well understood before a smart structure system can be implemented. A mathematical model has been developed for a crack that is situated on or near the boundary of a circular hole; this is relevant to such problems as the dynamic interaction between a fastener hole and a neighboring crack. The results thus obtained show that the detection zone for such hidden flaws can be established. AIAA

A93-32918* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OPTICAL FIBER SENSOR FOR TEMPERATURE MEASUREMENT FROM 600 TO 1900 C IN GAS TURBINE ENGINES
G. W. TREGAY, P. R. CALABRESE, P. L. KAPLIN, and M. J. FINNEY (Conax Buffalo Corp., NY) *In* Specialty fiber optic systems for mobile platforms; Proceedings of the Meeting, Boston, MA, Sept. 5, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 38-47. refs
(Contract NAS3-15451)
Copyright

A temperature sensor system has been fabricated specifically for the harsh environment encountered in temperature measurement on gas turbine engines. Four components comprised the system: a thermally emissive source, a high temperature lightguide, a flexible optical cable and an electro-optic signal processor. The emissive source was located inside a sapphire rod so that the sapphire serves as both a lightguide and as a protective shroud. As the probe was heated, the thermal radiation from the emissive source increased with increasing temperature. The flexible optical cable was constructed with 200 micron core fiber and ruggedized for turbine engine applications. The electro-optic signal processor used the ratio of intensity in two wavelength intervals to determine a digital value of the temperature. The probe tip was operated above 1900 C in a low velocity propane flame and above 1500 C at Mach .37. Probe housings, optical cables, and signal processors were constructed and environmentally tested for the temperature and vibration experienced by turbine engine sensors. This technology was used to build an optical exhaust gas sensor for a General Electric Aircraft Engines F404 turbine. The four optical probes and optical cable were a functional replacement for four thermocouple probes. The system was ground tested for 50 hours with an excess of 1000 thermal cycles. This optical temperature sensor system measured gas temperature up to the operational limit of the turbine engine. Author

A93-32962
AN AUTOMATED DEVICE TO QUANTITATIVELY MEASURE THERMAL DEPOSITS FROM JFTOT HEATER TUBES BY INTERFEROMETRY
ROBERT E. MORRIS (U.S. Navy, Naval Research Lab., Washington) *In* Aviation fuel: Thermal stability requirements; Proceedings of the International Symposium, Toronto, Canada, June 26, 1991 Philadelphia, PA American Society for Testing and Materials 1992 p. 151-163. refs
Copyright

The practical value of the ASTM D3241 Jet Fuel Thermal Oxidation Test procedure for evaluating jet fuel thermal oxidation stability is limited by the lack of a quantitative measurement of heater tube deposition. This paper will describe an automated device which has been developed to determine deposit volumes by measurements of light interference. Data acquisition, data manipulation, and volume calculations are performed under control of menu-driven software on a personal computer. Within the applicable thickness range, the device provides a means to obtain a reliable measuremnet of deposit volume which is not affected by the tube composition. Author

A93-33088
DIAGNOSTIC IMAGE PROCESSING OF REMOTE OPERATING SEALS FOR AEROSPACE APPLICATION
C. O. NWAGBOSO (Bolton Inst. of Higher Education, United Kingdom) *In* Image understanding for aerospace applications; Proceedings of the Meeting, Munich, Germany, June 13, 14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 55-63. refs
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This paper discusses the use of image processing techniques for monitoring the performance of a sealing ring for an aircraft actuator. Methods of processing the images of a deforming seal ring and the mathematical relations between the computer acquired Cartesian images to the axisymmetric ring geometry are presented. Some of the features which allow the accurate interpretation of the images are discussed. The results obtained show the deformation of a seal ring under a hydrodynamic environment that exists in the actuator. Author (revised)

A93-33169* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLIED HIGH-SPEED IMAGING FOR THE ICING RESEARCH PROGRAM AT NASA LEWIS RESEARCH CENTER
HOWARD SLATER (NASA, Lewis Research Center, Cleveland, OH), JAY OWENS (Cortez III Services Corp., Brook Park, OH), and JAIWON SHIN (NASA, Lewis Research Center, Cleveland, OH) *In* Ultrahigh- and high-speed photography, videography, and photonics '91; Proceedings of the Meeting, San Diego, CA, July 24-26, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 174-189. Previously announced in STAR as N91-26490 refs
(Contract NAS3-24816)
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The Icing Research Tunnel at NASA Lewis Research Center provides scientists a scaled, controlled environment to simulate natural icing events. The closed-loop, low speed, refrigerated wind tunnel offers the experimental capability to test for icing certification requirements, analytical model validation and calibration techniques, cloud physics instrumentation refinement, advanced ice protection systems, and rotorcraft icing methodology development. The test procedures for these objectives all require a high degree of visual documentation, both in real-time data acquisition and post-test image processing. Information is provided to scientific, technical, and industrial imaging specialists as well as to research personnel about the high-speed and conventional imaging systems will be on the recent ice protection technology program. Various imaging examples for some of the tests are presented. Additional imaging examples are available from the NASA Lewis Research Center's Photographic and Printing Branch. Author

N93-22197*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THREE-DIMENSIONAL LASER WINDOW FORMATION FOR INDUSTRIAL APPLICATION
VINCENT G. VERHOFF and DAVID KOWALSKI *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 454-459 Feb. 1993
Avail: CASI HC A04/MF A04

The NASA Lewis Research Center has developed and implemented a unique process for forming flawless three-dimensional, compound-curvature laser windows to extreme accuracies. These windows represent an integral component of specialized nonintrusive laser data acquisition systems that are used in a variety of compressor and turbine research testing facilities. These windows are molded to the flow surface profile of turbine and compressor casings and are required to withstand extremely high pressures and temperatures. This method of glass formation could also be used to form compound-curvature mirrors that would require little polishing and for a variety of industrial applications, including research view ports for testing devices and view ports for factory machines with compound-curvature casings. Currently, sodium-alumino-silicate glass is recommended for three-dimensional laser windows because of its high strength due to chemical strengthening and its optical clarity. This paper

discusses the main aspects of three-dimensional laser window formation. It focuses on the unique methodology and the peculiarities that are associated with the formation of these windows. Author

N93-22326# Los Alamos National Lab., NM.
NONINTRUSIVE TEMPERATURE MEASUREMENTS ON ADVANCED TURBOMACHINERY COMPONENTS
B. W. NOEL, W. D. TURLEY (EG and G Energy Measurements, Inc., Idaho Falls.), and W. LEWIS (EG and G Energy Measurements, Inc., Idaho Falls.) 1992 28 p Presented at the Latin American Conference on Turbomachinery, Cuernavaca, Mexico, 15-18 Feb. 1993
(Contract W-7405-ENG-36)
(DE93-005478; LA-UR-92-4227; CONF-930249-1) Avail: CASI HC A03/MF A01

A nonintrusive, noncontacting method we developed for temperature measurements in hostile environments is well-suited for measurements on advanced turbine components. The method is not only superior to thermocouples in sufficiently difficult environments, but also is the only known method for making measurements in situations where no form of pyrometry works. We demonstrated the method, which uses laser-induced fluorescence of thermographic phosphors bonded to the component surfaces, on turbine blades and vanes in developmental turbine engines. The method is extendable to the much-higher temperatures expected inside advanced turbomachinery. Of particular note is the adaptability of the method to surface-temperature measurements on ceramics operating at high temperatures. In this temperature range, the ceramics become translucent, and surface emissivity becomes meaningless. We shall discuss the method, its advantages and limitations, recent test results on operating turbine engines, and the extension to ceramic components. DOE

N93-22466*# *McDonnell-Douglas Helicopter Co., Mesa, AZ.*
ADVANCED ROTORCRAFT TRANSMISSION (ART) PROGRAM Final Report
GREGORY F. HEATH and ROBERT B. BOSSLER, JR. (Lucas Western, Inc., City of Industry, CA.) Jan. 1993 222 p
(Contract NAS3-25454; DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-OK)
(NASA-CR-191057; ARL-CR-14; NAS 1.26:191057) Avail: CASI HC A10/MF A03

Work performed by the McDonnell Douglas Helicopter Company and Lucas Western, Inc. within the U.S. Army/NASA Advanced Rotorcraft Transmission (ART) Program is summarized. The design of a 5000 horsepower transmission for a next generation advanced attack helicopter is described. Government goals for the program were to define technology and detail design the ART to meet, as a minimum, a weight reduction of 25 percent, an internal noise reduction of 10 dB plus a mean-time-between-removal (MTBR) of 5000 hours compared to a state-of-the-art baseline transmission. The split-torque transmission developed using face gears achieved a 40 percent weight reduction, a 9.6 dB noise reduction and a 5270 hour MTBR in meeting or exceeding the above goals. Aircraft mission performance and cost improvements resulting from installation of the ART would include a 17 to 22 percent improvement in loss-exchange ratio during combat, a 22 percent improvement in mean-time-between-failure, a transmission acquisition cost savings of 23 percent of $165K, per unit, and an average transmission direct operating cost savings of 33 percent, or $24K per flight hour. Face gear tests performed successfully at NASA Lewis are summarized. Also, program results of advanced material tooth scoring tests, single tooth bending tests, Charpy impact energy tests, compact tension fracture toughness tests and tensile strength tests are summarized. Author (revised)

N93-22481*# Sverdrup Technology, Inc., Brook Park, OH. Research Center Group.
COUPLED MULTI-DISCIPLINARY COMPOSITES BEHAVIOR SIMULATION
SURENDRA N. SINGHAL, PAPPU L. N. MURTHY (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.), and CHRISTOS C. CHAMIS (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.) Feb. 1993 77 p Original contains color illustrations
(Contract RTOP 505-63-53)
(NASA-TM-106011; E-7565; NAS 1.15:106011) Avail: CASI HC A05/MF A01; 3 functional color pages

The capabilities of the computer code CSTEM (Coupled Structural/Thermal/Electro-Magnetic Analysis) are discussed and demonstrated. CSTEM computationally simulates the coupled response of layered multi-material composite structures subjected to simultaneous thermal, structural, vibration, acoustic, and electromagnetic loads and includes the effect of aggressive environments. The composite material behavior and structural response is determined at its various inherent scales: constituents (fiber/matrix), ply, laminate, and structural component. The thermal and mechanical properties of the constituents are considered to be nonlinearly dependent on various parameters such as temperature and moisture. The acoustic and electromagnetic properties also include dependence on vibration and electromagnetic wave frequencies, respectively. The simulation is based on a three dimensional finite element analysis in conjunction with composite mechanics and with structural tailoring codes, and with acoustic and electromagnetic analysis methods. An aircraft engine composite fan blade is selected as a typical structural component to demonstrate the CSTEM capabilities. Results of various coupled multi-disciplinary heat transfer, structural, vibration, acoustic, and electromagnetic analyses for temperature distribution, stress and displacement response, deformed shape, vibration frequencies, mode shapes, acoustic noise, and electromagnetic reflection from the fan blade are discussed for their coupled effects in hot and humid environments. Collectively, these results demonstrate the effectiveness of the CSTEM code in capturing the coupled effects on the various responses of composite structures subjected to simultaneous multiple real-life loads. Author

N93-22598*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICING RESEARCH TUNNEL ROTATING BAR CALIBRATION MEASUREMENT SYSTEM
THERESA L. GIBSON and JOHN M. DEARMON (Sverdrup Technology, Inc., Brook Park, OH.) Mar. 1993 16 p Prepared for presentation at the 39th Aerospace Industries/Test Measurement Symposium, Albuquerque, NM, 3-6 May 1993; sponsored by the Instrument Society of America
(Contract RTOP 505-62-84)
(NASA-TM-106010; E-7539; NAS 1.15:106010) Avail: CASI HC A03/MF A01

In order to measure icing patterns across a test section of the Icing Research Tunnel, an automated rotating bar measurement system was developed at the NASA Lewis Research Center. In comparison with the previously used manual measurement system, this system provides a number of improvements: increased accuracy and repeatability, increased number of data points, reduced tunnel operating time, and improved documentation. The automated system uses a linear variable differential transformer (LVDT) to measure ice accretion. This instrument is driven along the bar by means of an intelligent stepper motor which also controls data recording. This paper describes the rotating bar calibration measurement system. Author

N93-22721# Sandia National Labs., Albuquerque, NM.
EFFECT OF THE FLAP AND EDGEWISE BENDING MOMENT PHASE RELATIONSHIPS ON THE FATIGUE LOADS OF A TYPICAL HAWT BLADE
H. J. SUTHERLAND 1992 7 p Presented at the 12th American Society Mechanical Engineers Wind Energy Symposium, Houston, TX, 31 Jan. - 4 Feb. 1993
(Contract DE-AC04-76DP-00789)
(DE93-003253; SAND-92-1665C; CONF-930153-1) Avail: CASI HC A02/MF A01

The load spectrum unposed upon a horizontal-axis wind turbine blade is typically decomposed into two primary bending moments; flap and edgewise bending. The critical fatigue loads (stress cycles) imposed on the blade may not be on one of these axes, especially if die two bending loads are in-phase with one another. To quantify the correlation of these two bending moments and determine the impact of this correlation on off-axis fatigue loads, an extensive data set for a typical wind turbine blade is examined. The results are compared using their respective cycle count matrices. These results illustrate that the harmonic components of die principal bending stresses are correlated, and that the random components are not. The analysis techniques described in the paper provide the turbine designer with a spectral technique for combining primary bending spectra into off-axis fatigue loads. DOE

N93-22783# Litton Guidance and Control Systems, Woodland Hills, CA.

AN OVERVIEW OF OPTICAL GYROSCOPES FOR NAVIGATION

J. G. MARK and D. A. TAZARTES *In* AGARD, Integrated and Multi-Function Navigation 9 p Nov. 1992

Copyright Avail: CASI HC A02/MF A02

In the 1980's, Ring Laser Gyroscopes (RLG) displaced the mechanical (spinning wheel) gyroscope as the angular sensor of choice for navigation. While the RLG remains the standard navigation grade instrument, several other optical gyroscopes have recently appeared. The multi oscillator (or four-mode gyro) represents a new generation in laser gyroscopes. Systems based on this technology are now being delivered for use on commercial and military aircraft. Another optical sensor, the fiber optic gyroscope (FOG) has been incorporated in inertial measurement units (IMU) and proved itself capable of AHRS (attitude and heading reference system) accuracy. This gyroscope should find many applications in aided navigation systems. Integrated FOG/GPS systems appear attractive as low cost navigators. This paper addresses technology involved in these optical gyroscopes and discusses their advantages and disadvantages in relation to present and future applications. Author

N93-22786# Sextant Avionique, Valence (France).

SILICON ACCELEROMETER FOR AHRS AND HYBRID NAVIGATION SYSTEMS [ACCELEROMETRE SILICIUM POUR AHRS ET SYSTEMES HYBRIDES DE NAVIGATION]

J. LECLERC, A. DEFOSSE, and O. LEFORT *In* AGARD, Integrated and Multi-Function Navigation 5 p Nov. 1992 In FRENCH

Copyright Avail: CASI HC A01/MF A02

The SEXTANT Avionic company possesses a large spectrum of accelerometers for the different applications of Navigation. Since 1980, a constant concern about their adequacy to meet the need has led SEXTANT Avionic to develop micro-machined captors and accelerometers in particular. Many types of materials have been used and we expose the reasons for the choice of silicon in accelerometers destined for AHRS. The architecture of the accelerometer, the technologies used, and the functional modes are described. Then the actual performances of the different types of silicon accelerometers are explained, as well as their domain of application. In conclusion, perspectives of a longer term are given. Author

N93-22817*# Queensland Univ., Saint Lucia (Australia). Dept. of Mechanical Engineering.

SHOCK TUNNEL STUDIES OF SCRAMJET PHENOMENA, SUPPLEMENT 6

M. WENDT, M. NETTLETON, R. G. MORGAN, K. SKINNER, R. CASEY, R. STALKER, C. BRESCIANINI, A. PAULL, G. ALLEN, M. SMART et al. Feb. 1993 230 p

(Contract NAGW-674; RTOP 505-70-62-02)

(NASA-CR-191428; NAS 1.26:191428) Avail: CASI HC A11/MF A03

Reports by the staff of the University of Queensland on various research studies related to the advancement of scramjet technology are presented. These reports document the tests conducted in the reflected shock tunnel T4 and supporting research facilities that have been used to study the injection, mixing, and combustion of hydrogen fuel in generic scramjets at flow conditions typical of hypersonic flight. In addition, topics include the development of instrumentation and measurement technology, such as combustor wall shear and stream composition in pulse facilities, and numerical studies and analyses of the scramjet combustor process and the test facility operation. Author

N93-22826*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EVALUATION OF AN OIL-DEBRIS MONITORING DEVICE FOR USE IN HELICOPTER TRANSMISSIONS

DAVID G. LEWICKI, DONALD M. BLANCHETTE (National Defence Headquarters, Ottawa, Ontario.), and GILLES BIRON (Quality Engineering Test Establishment, Hull, Quebec.) Aug. 1992 19 p

(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-63-36)

(NASA-TM-105830; E-7265; NAS 1.15:105830;

AVSCOM-TR-92-C-007) Avail: CASI HC A03/MF A01

Experimental tests were performed on an OH-58A helicopter main-rotor transmission to evaluate an oil-debris monitoring device (ODMD). The tests were performed in the NASA 500-hp Helicopter Transmission Test Stand. Five endurance tests were run as part of a U.S. Navy/NASA/Army advanced lubricants program. The tests were run at 100 percent design speed, 117-percent design torque, and 121 C (250 F) oil inlet temperature. Each test lasted between 29 and 122 hr. The oils that were used conformed to MIL-L-23699 and DOD-L-85734 specifications. One test produced a massive sun-gear fatigue failure; another test produced a small spall on one sun-gear tooth; and a third test produced a catastrophic planet-bearing cage failure. The ODMD results were compared with oil spectroscopy results. The capability of the ODMD to detect transmission component failures was not demonstrated. Two of the five tests produced large amounts of debris. For these two tests, two separate ODMD sensors failed, possibly because of prolonged exposure to relatively high oil temperatures. One test produced a small amount of debris and was not detected by the ODMD or by oil spectroscopy. In general, the ODMD results matched the oil spectroscopy results. The ODMD results were extremely sensitive to oil temperature and flow rate. Author

N93-22867# Argonne National Lab., IL.

AUTOMATIC DIFFERENTIATION OF ADVANCED CFD CODES FOR MULTIDISCIPLINARY DESIGN

C. BISCHOF, G. CORLISS, A. GRIEWANK, L. GREEN, K. HAIGLER, and P. NEWMAN 1992 17 p Presented at the Symposium on High-performance Computing for Flight Vehicles, Arlington, VA, 7-9 Dec. 1992

(Contract W-31-109-ENG-38)

(DE93-005685; ANL/MCS/CP-78197; CONF-921243-1) Avail: CASI HC A03/MF A01

Automated multidisciplinary design of aircraft and other flight vehicles requires the optimization of complex performance objectives with respect to a number of design parameters and constraints. The effect of these independent design variables on the system performance criteria can be quantified in terms of sensitivity derivatives which must be calculated and propagated by the individual discipline simulation codes. Typical advanced CFD analysis codes do not provide such derivatives as part of a flow solution; these derivatives are very expensive to obtain by divided (finite) differences from perturbed solutions. It is shown that sensitivity derivatives can be obtained accurately and efficiently using the ADIFOR source translator for automatic differentiation. In particular, it is demonstrated that the 3-D, thin-layer Navier-Stokes, multigrid flow solver called TLNS3D is amenable to automatic differentiation in the forward mode even with its implicit iterative solution algorithm and complex turbulence modeling. It is significant that by using computational differentiation, consistent discrete nongeometric sensitivity derivatives have been obtained from an aerodynamic 3-D CFD code in a relatively short time, e.g., O(man-week) not O(man-year). DOE

N93-23019*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LOW-NOISE, HIGH-STRENGTH, SPIRAL-BEVEL GEARS FOR HELICOPTER TRANSMISSIONS
DAVID G. LEWICKI, ROBERT F. HANDSCHUH, ZACHARY S. HENRY (Bell Helicopter Co., Fort Worth, TX.), and FAYDOR L. LITVIN (Chicago Univ., IL.) Jun. 1993 15 p Proposed for presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, 28-30 Jun. 1993; sponsored by AIAA, SAE, ASME, and ASEE
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-10)
(NASA-TM-106080; E-7698; NAS 1.15:106080; AIAA PAPER 93-2149; ARL-MR-71) Avail: CASI HC A03/MF A01

Improvements in spiral-bevel gear design were investigated to support the Army/NASA Advanced Rotorcraft Transmission program. Program objectives were to reduce weight by 25 percent, reduce noise by 10 dB, and increase life to 5000 hr mean-time-between-removal. To help meet these goals, advanced-design spiral-bevel gears were tested in an OH-58D helicopter transmission using the NASA 500-hp Helicopter Transmission Test Stand. Three different gear designs tested included: (1) the current design of the OH-58D transmission except gear material X-53 instead of AISI 9310; (2) a higher-strength design the same as the current but with a full fillet radius to reduce gear tooth bending stress (and thus, weight); and (3) a lower-noise design the same as the high-strength but with modified tooth geometry to reduce transmission error and noise. Noise, vibration, and tooth strain tests were performed and significant gear stress and noise reductions were achieved. Author

N93-23020# Technische Univ., Berlin (Germany). Inst. of Aeronautics and Astronautics.
STABILITY AND STABILITY DEGREE OF A CRACKED FLEXIBLE ROTOR SUPPORTED ON JOURNAL BEARINGS
MENG GUENG (Northwestern Polytechnical Univ., Xian, China.) and ROBERT GASCH Jan. 1992 45 p Sponsored by Alexander von Humboldt Foundation, and DFG
(ILR-MITT-268(1991); ETN-93-93460) Avail: CASI HC A03/MF A01

The stability and the stability degree of a flexible cracked rotor supported on different kinds of journal bearings were investigated. The influences of the crack stiffness ratio, the fixed Sommerfeld number, the gravity parameter, and the mass ratio were analyzed. It was found that the rotor crack has almost no influence on the system stability and stability degree outside the crack ridge zones; while within the crack ridge zones, the stability and stability degree depend both on the crack and system parameters. In some cases, the system may still be stable even when the crack is very large. The influence of mass ratio on the stability degree is small and the influence of fixed Sommerfeld number on the crack stability degree is small although the Sommerfeld number has a large influence on the stability degree of uncracked rotor. ESA

N93-23046# Federal Aviation Administration, Atlantic City, NJ.
CONTROLLER EVALUATION OF INITIAL TERMINAL DATA LINK ATC SERVICES: MINI STUDY 3 Final Report
Dec. 1992 138 p
(Contract FAA-T2001-B)
(DOT/FAA/CT-92/18) Avail: CASI HC A07/MF A02

This report documents the third Federal Aviation Administration (FAA) controller evaluation of an initial group of four terminal air traffic control (ATC) services and functions which are under development for implementation on a Data Link airground communications system. The research was conducted at the Federal Aviation Administration Technical Center by the Research Directorate for Aviation Technology, Airborne Collision Avoidance and Data Systems Branch, ACD-320. Author

N93-23059*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SUMMARY OF EXPERIMENTAL HEAT-TRANSFER RESULTS FROM THE TURBINE HOT SECTION FACILITY
HERBERT J. GLADDEN and FREDRICK C. YEH Apr. 1993 216 p
(Contract RTOP 505-62-52)
(NASA-TP-3250; E-6615; NAS 1.60:3250) Avail: CASI HC A10/MF A03

Experimental data from the turbine Hot Section Facility are presented and discussed. These data include full-coverage film-cooled airfoil results as well as special instrumentation results obtained at simulated real engine conditions. Local measurements of airfoil wall temperature, airfoil gas-path static-pressure distribution, and local heat-transfer coefficient distributions are presented and discussed. In addition, measured gas and coolant temperatures and pressures are presented. These data are also compared with analyses from Euler and boundary-layer codes. Author

N93-23110 Mississippi State Univ., State College.
INCOMPRESSIBLE NAVIER-STOKES ALGORITHM FOR FLOW AND HEAT TRANSFER OVER ROUGH SURFACES Ph.D. Thesis
KENTON RIDGEWAY FLEMING 1992 110 p
Avail: Univ. Microfilms Order No. DA9237050

The development of a computer model for simulation of incompressible turbulent flow and heat transfer over rough surfaces using the discrete element method is presented. The discrete element roughness model is implemented into an existing incompressible Navier-Stokes algorithm. This algorithm is a finite volume, incompressible Navier-Stokes solver which uses artificial compressibility and the Roe approximate Riemann solver, also referred to as the flux difference split method. The equations solved in this code were modified to include surface roughness effects in the flow. Details of the roughness effects on the flow are modeled empirically instead of being resolved in the computational geometry. The roughness element from drag and heat transfer are treated as volumetric sink and source terms, respectively. Cases were treated for flow and convective heat transfer over smooth and rough flat plates with different free stream velocities and roughness distributions. Also, flow computations were performed for an axisymmetric body with an inflected curved stern and a NACA-0012 airfoil. The rough flow prediction model was observed to simulate the effects of surface roughness accurately; in one case flow separation was indicated. In all cases the computed effects of surface roughness were observed to yield higher skin friction than the equivalent flow over a smooth surface. For the case of computed heat transfer over the flat plate, roughness increased heat transfer. Dissert. Abstr.

N93-23188 Cleveland State Univ., OH.
PLANETARY GEAR TRAIN RING GEAR AND SUPPORT STRUCTURE INVESTIGATION Ph.D. Thesis
MARK J. VALCO 1992 357 p
Avail: Univ. Microfilms Order No. DA9237171

Most helicopter transmissions utilize a planetary gear train as the final speed reduction stage. Due to weight constraints these transmissions have high power-to-weight ratios and relatively flexible structures. This investigation addresses the analysis of planetary gear trains with the ring gear mounted on a flexible support structure. The approach utilizes recent advances in automated contact methods for nonlinear finite element analysis. Rather than using a line of action spring to model gear pair mesh stiffness, finite element models of complete gears are developed, and the elastic gear members are engaged and rolled through mesh. The procedure includes detailed gear tooth geometry with profile modifications. A nonlinear approach is required due to large displacements associated with gear rotation and nonlinear boundary conditions associated with the gear tooth surface contact. The updated Lagrangian formulation and the MARC K-4.1 automated contact features are applied in the analysis. The ring gear support structure is modeled by an elastic foundation linking the ring gear to a rigid support. Calculation of gear pair deflections, stresses, transmission error, and mesh stiffness through the gear meshing cycle are demonstrated for external and internal spur gear pairs and a planetary gear train. Issues relating to the accuracy

of the nonlinear finite element contact method, gear mesh stiffness, transmission error, and the planetary gear train elastic support structure are discussed. Dissert. Abstr.

N93-23195*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
RLE PROGRESS REPORT NO. 133, 1 JANUARY - 31 DECEMBER 1990
JONATHAN ALLEN, DANIEL KLEPPNER, MARY J. ZIEGLER, ed., and BARBARA PASSERO, ed. 31 Dec. 1990 15 p
(Contract NAGW-1272) (ISSN 0163-9218)
(NASA-CR-192144; NAS 1.26:192144) Copyright Avail: CASI HC A03/MF A01

Activities of the Research Laboratory of Electronics at MIT are summarized. NASA-sponsored research in the area of synthetic aperture radar image interpretation and simulation is described. Other government-sponsored and industry-sponsored studies are also described which address the following topics: microwave and millimeter wave integrated circuits, high-speed integrated circuit interconnects, Instrument Landing System/Microwave Landing System frequency management assessment, and superconducting electronics. CASI

N93-23234*# MCAT Inst., San Jose, CA.
ALGORITHM AND CODE DEVELOPMENT FOR UNSTEADY THREE-DIMENSIONAL NAVIER-STOKES EQUATIONS
SHIGERU OBAYASHI Mar. 1993 82 p Original contains color illustrations
(Contract NCC2-605)
(NASA-CR-192760; NAS 1.26:192760; MCAT-93-08) Avail: CASI HC A05/MF A01; 3 functional color pages

In the last two decades, there have been extensive developments in computational aerodynamics, which constitutes a major part of the general area of computational fluid dynamics. Such developments are essential to advance the understanding of the physics of complex flows, to complement expensive wind-tunnel tests, and to reduce the overall design cost of an aircraft, particularly in the area of aeroelasticity. Aeroelasticity plays an important role in the design and development of aircraft, particularly modern aircraft, which tend to be more flexible. Several phenomena that can be dangerous and limit the performance of an aircraft occur because of the interaction of the flow with flexible components. For example, an aircraft with highly swept wings may experience vortex-induced aeroelastic oscillations. Also, undesirable aeroelastic phenomena due to the presence and movement of shock waves occur in the transonic range. Aeroelastically critical phenomena, such as a low transonic flutter speed, have been known to occur through limited wind-tunnel tests and flight tests. Aeroelastic tests require extensive cost and risk. An aeroelastic wind-tunnel experiment is an order of magnitude more expensive than a parallel experiment involving only aerodynamics. By complementing the wind-tunnel experiments with numerical simulations the overall cost of the development of aircraft can be considerably reduced. In order to accurately compute aeroelastic phenomenon it is necessary to solve the unsteady Euler/Navier-Stokes equations simultaneously with the structural equations of motion. These equations accurately describe the flow phenomena for aeroelastic applications. At Ames a code, ENSAERO, is being developed for computing the unsteady aerodynamics and aeroelasticity of aircraft and it solves the Euler/Navier-Stokes equations. The purpose of this contract is to continue the algorithm enhancements of ENSAERO and to apply the code to complicated geometries. During the last year, the geometric capability of the code was extended to simulate transonic flows, a wing with oscillating control surface. Single-grid and zonal approaches were tested. For the zonal approach, a new interpolation technique was introduced. The key development of the algorithm was an interface treatment between moving zones for a control surface using the virtual-zone concept. The work performed during the period, 1 Apr. 1992 through 31 Mar. 1993 is summarized. Additional details on the various aspects of the study are given in the Appendices. Author (revised)

N93-23477# Orincon Corp., La Jolla, CA.
CONDITION BASED MACHINERY MAINTENANCE (HELICOPTER FAULT DETECTION), PHASE 1 Final Report
T. W. BROTHERTON and T. G. POLLARD 29 Jan. 1993 42 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract N00014-92-C-0059)
(AD-A259774) Avail: CASI HC A03/MF A01

A problem of current interest to the Navy is the automatic detection and classification of faults in mechanical systems such as the transmissions, gearboxes, and bearings of helicopters. The problem is important for both economic and safety reasons. Using automated fault detection and classification, machinery repair can be undertaken as needed and can prevent catastrophic failure. This condition-based maintenance approach is more efficient and cost-effective than the use of predetermined maintenance schedules. Additionally, automated fault detection and classification systems can alert machinery operators, such as helicopter pilots, of the onset of a mechanical problem, thus allowing the pilot to take precautions, such as landing the aircraft, before a potentially catastrophic failure occurs. GRA

N93-23514# Lufthansa German Airlines, Frankfurt (Germany).
AIRLINE APPLICATIONS IN AIR-/GROUND COMMUNICATION USING ADVANCED TECHNOLOGIES
HEINRICH MENSEN *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 37-38 Jul. 1992
Copyright Avail: CASI HC A01/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

The involvement of the German airline Lufthansa in the further development of air/ground communication is outlined. Air/ground communication is defined as the overall complex of data and voice communication meeting the specific requirements of internal airline affairs, passenger services, and air traffic control. In particular, applications in Aeronautical Operational Control (AOC), Aeronautical Administrative Communications (AAC), ATS (Air Traffic Services), and APC (Aeronautical Passenger Communications), are described. ESA

N93-23518# Air Navigation Technical Service, Paris (France).
THE FUTURE ROLE OF SATELLITE COMMUNICATIONS IN AN IMPROVED AIR TRAFFIC MANAGEMENT
PATRICE GAUTHIER (Service Technique de la Navigation Aerienne, Paris, France.) *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 57-60 Jul. 1992
Copyright Avail: CASI HC A01/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

The need for air to ground communication in Air Traffic Control (ATC) is discussed and a summary on the birth of aeronautical satellite communication is given. The standardization of an aeronautical mobile communications service by the International Civil Aviation Organization is reported. The feasibility analysis of satellite communications for ATC carried out by the French civil aviation is described. This 'South Pacific Trial' is regarded as a first step towards a full operational implementation. ESA

N93-23525# Centre d'Etudes de la Navigation Aerienne, Toulouse (France).
OSI APPLIED TO AERONAUTICAL SATELLITE MOBILE COMMUNICATIONS IN EURATN
FRANCK MONTEIL *In* ESA, Environment Observation and Climate Modelling Through International Space Projects. Navigation and Mobile Communications. Image Processing, GIS, and Space-Assisted Mapping p 97-102 Jul. 1992
Copyright Avail: CASI HC A02/MF A04; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC

The future Aeronautical Telecommunication Network ATN being standardized by ICAO (International Civil Aviation Organization) and application of OSI (Open Systems Interconnection) are

described. The concepts developed by paper work have reached such a maturity that a validation step is now essential in parallel with futher ATN specification activity. This validation requires the development of an experimental ATN. This is the aim of the EURATN project. The Satcom satellite subnetwork will be part of this experimental ATN. The EURATN project will provide an experimental ATN, both for the validation aspects mentioned above and for ATM (Air Traffic Management) enhancement trials. Such experimental activities will be performed after EURATN completion, possibly in the frame of a EURATN 2 project. ESA

N93-23591 Syracuse Univ., NY.
WAKE-INDUCED UNSTEADY STAGNATION REGION HEAT TRANSFER MEASUREMENTS Ph.D. Thesis
PATRICK JOSEPH MAGARI 1992 247 p
Avail: Univ. Microfilms Order No. DA9229689

An experimental investigation of wake-induced unsteady heat transfer in the stagnation region of a cylinder is presented. The objective of the study was to create a quasi-steady representation of the stator/rotor interaction in a gas turbine using two stationary cylinders. In this simulation, a larger cylinder, representing the leading-edge region of a rotor blade was immersed in the wake of a smaller cylinder, representing the trailing-edge region of a stator vane. The experiment was conducted in a short-duration, compression-heated wind tunnel which allowed for independent control of Mach number, Reynolds number, and gas-to-wall temperature ratio. Measurements were performed at a gas-to-wall temperature ratio of 1.35 and Mach numbers of 0.1 and 0.5 with range of 67,500-112,000 and 112,000-383,000, respectively. The background freestream turbulence intensity was less than 0.5 percent, and turbulence grids were utilized to enhance these levels to 4.5 percent at M infinity = 0.08 and 1.75 percent at M infinity = 0.5. Low-speed, isolated-cylinder heat-transfer results compared well with the results of previous investigations, but at the transonic Mach number (M infinity = 0.5), the heat-transfer rate decreased faster with the circumferential distance from the stagnation point. The wake-interaction results were obtained with two wake-generating cylinder diameters of 0.25 and 0.125 times the instrumented cylinder diameter. The streamwise separations between the leading edge of the instrumented cylinder and the centerline of the wake-generating cylinder were 8 and 16 wake-generator diameters. The mean and rms variation of the heat-transfer signals, cross-correlations between various gauges, and spectral analyses of the unsteady heat-transfer signals are presented. The stagnation-point heat transfer was found to reach a maximum independent of the Reynolds number and wake-generator diameter when presented in terms of the Frossling number (NU/square root of Re) at high values of the turbulence parameter Tu/square root of Re. Freestream turbulence levels had no appreciable effect upon the results. The power spectra and wavelet transforms of the heat-transfer signals revealed the importance of large vortical structures in the wake to the unsteady component of the heat transfer in the stagnation region.
Dissert. Abstr.

N93-23744*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SPRAY COMBUSTION EXPERIMENTS AND NUMERICAL PREDICTIONS
EDWARD J. MULARZ, DANIEL L. BULZAN, and KUO-HUEY CHEN (Toledo Univ., OH.) 1993 23 p Proposed for presentation at the AGARD Symposium on Fuels and Combustion Technology for Advanced Gas Turbine Engines, Rome, Italy, Spring 1993; sponsored by the Advisory Group for Aerospace Research and Development Original contains color illustrations
(Contract DA PROJ. 1L1-61102-AH-45)
(NASA-TM-106069; E-7647; NAS 1.15:106069; ARL-MR-69)
Avail: CASI HC A03/MF A01; 2 functional color pages

The next generation of commercial aircraft will include turbofan engines with performance significantly better than those in the current fleet. Control of particulate and gaseous emissions will also be an integral part of the engine design criteria. These performance and emission requirements present a technical challenge for the combustor: control of the fuel and air mixing and control of the local stoichiometry will have to be maintained much more rigorously than with combustors in current production. A better understanding of the flow physics of liquid fuel spray combustion is necessary. This paper describes recent experiments on spray combustion where detailed measurements of the spray characteristics were made, including local drop-size distributions and velocities. Also, an advanced combustor CFD code has been under development and predictions from this code are compared with experimental results. Studies such as these will provide information to the advanced combustor designer on fuel spray quality and mixing effectiveness. Validation of new fast, robust, and efficient CFD codes will also enable the combustor designer to use them as additional design tools for optimization of combustor concepts for the next generation of aircraft engines. Author

N93-23746*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATIONAL SIMULATION FOR CONCURRENT ENGINEERING OF AEROSPACE PROPULSION SYSTEMS
C. C. CHAMIS and S. N. SINGHAL (Sverdrup Technology, Inc., Brook Park, OH.) Feb. 1993 23 p Presented at the 1992 AIAA Aerospace Design Conference, Irvine, CA, 3-6 Feb. 1992 Previously announced in IAA as A92-33285
(Contract RTOP 323-57-40)
(NASA-TM-106029; E-7592; NAS 1.15:106029) Avail: CASI HC A03/MF A01

Results are summarized for an investigation to assess the infrastructure available and the technology readiness in order to develop computational simulation methods/software for concurrent engineering. These results demonstrate that development of computational simulation methods for concurrent engineering is timely. Extensive infrastructure, in terms of multi-discipline simulation, component-specific simulation, system simulators, fabrication process simulation, and simulation of uncertainties--fundamental to develop such methods, is available. An approach is recommended which can be used to develop computational simulation methods for concurrent engineering of propulsion systems and systems in general. Benefits and issues needing early attention in the development are outlined.
Author (revised)

N93-24065# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
SCIENTIFIC VISUALIZATION OF VOLUMETRIC RADAR CROSS SECTION DATA M.S. Thesis
THOMAS G. WOJSZYNSKI Dec. 1992 69 p
(AD-A259586; AFIT/GCS/ENG/92D-21) Avail: CASI HC A04/MF A01

For aircraft design and mission planning, designers, threat analysts, mission planners, and pilots require a Radar Cross Section (RCS) central tendency with its associated distribution about a specified aspect and its relation to a known threat, Historically, RCS data sets have been statically analyzed to evaluate a d profile. However, Scientific Visualization, the application of computer graphics techniques to produce pictures of complex physical phenomena appears to be a more promising tool to interpret this data. This work describes data reduction techniques and a surface rendering algorithm to construct and display a complex polyhedron from adjacent contours of RCS data. Data reduction is accomplished by sectorizing the data and characterizing the statistical properties of the data. Color, lighting, and orientation cues are added to complete the visualization system. The tool may be useful for synthesis, design, and analysis of complex, low observable air vehicles. GRA

N93-24096*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATIC AND AEROTHERMAL TESTS OF A SUPERALLOY HONEYCOMB PREPACKAGED THERMAL PROTECTION SYSTEM
MARK P. GORTON (Lockheed Engineering and Sciences Co., Hampton, VA.), JOHN L. SHIDELER, and GRANVILLE L. WEBB

Washington Mar. 1993 51 p
(Contract RTOP 506-43-71-04)
(NASA-TP-3257; L-17084; NAS 1.60:3257) Avail: CASI HC A04/MF A01

A reusable metallic thermal protection system has been developed for vehicles with maximum surface temperatures of up to 2000 F. An array of two 12- by 12-in. panels was subjected to radiant heating tests that simulated Space Shuttle entry temperature and pressure histories. Results indicate that this thermal protection system, with a mass of 2.201 lbm/ft(exp 2), can successfully prevent typical aluminum primary structure of an entry vehicle like the Space Shuttle from exceeding temperatures greater than 350 F at a location on the vehicle where the maximum surface temperature is 1900 F. A flat array of 20 panels was exposed to aerothermal flow conditions, at a Mach number of 6.75. The panels were installed in a worst-case orientation with the gaps between panels parallel to the flow. Results from the aerothermal tests indicated that convective heating occurred from hot gas flow in the gaps between the panels. Proposed design changes to prevent gap heating occurred from hot gas flow in the gaps between the panels. Proposed design changes to prevent gap heating include orienting panels so that gaps are not parallel to the flow and using a packaged, compressible gap-filler material between panels to block hot gas flow in the gaps. Author

N93-24102*# Sverdrup Technology, Inc., Brook Park, OH. Research Center Group.
BLADE ASSESSMENT FOR ICE IMPACT (BLASIM). USER'S MANUAL, VERSION 1.0
E. S. REDDY and G. H. ABUMERI Apr. 1993 128 p
(Contract NAS3-25266; RTOP 505-62-OK)
(NASA-CR-191075; E-7733; NAS 1.26:191075) Avail: CASI HC A07/MF A02

The Blade Assessment Ice Impact (BLASIM) computer code can analyze solid, hollow, composite, and super hybrid blades. The solid blade is made up of a single material where hollow, composite, and super hybrid blades are constructed with prescribed composite layup. The properties of a composite blade can be specified by inputting one of two options: (1) individual ply properties, or (2) fiber/matrix combinations. When the second option is selected, BLASIM utilizes ICAN (Integrated Composite ANalyzer) to generate the temperature/moisture dependent ply properties of the composite blade. Two types of geometry input can be given: airfoil coordinates or NASTRAN type finite element model. These features increase the flexibility of the program. The user's manual provides sample cases to facilitate efficient use of the code while gaining familiarity. Author (revised)

N93-24213 Bristol Univ. (England).
SEPARATED FLOW PAST SMOOTH SLENDER BODIES Ph.D. Thesis
ANN LOUISE WILLIAMS 1991 349 p
Avail: Univ. Microfilms Order No. BRDX97391

This dissertation describes an investigation of the separated flow past slender bodies at high angles of attack. Flows of this type occur on aircraft and missile forebodies and can develop large forces which are important when considering stability and control of the vehicle. The objective of this work is to extend the vortex sheet model, which has previously been implemented for slender wings and circular and elliptic cones, to cones of more general cross-section and to non-conical bodies. The cross-sections of the bodies studied here are basically square or triangular, but with rounded corners. The model is inviscid, so the separation positions must be prescribed. Two distinct families of solutions have been identified. For laterally symmetric configurations with symmetric separation positions and no yaw, the first family solutions are symmetric, whereas the second family solutions are asymmetric. For elliptic cones, it is known that cross-section thickness affects the degree of asymmetry of the flow and this represents a mechanism for the control of side forces. Square or triangular cross-sections with rounded corners are of interest to aerodynamicists and have been investigated to assess the effect on asymmetry of making a circular cross-section 'square' or 'triangular'. For 'square' and 'triangular' cones placed either side, or corner on to the flow, results are obtained which enable the effect of cross-section shape on the degree of asymmetry to be assessed. A non-conical vortex sheet model has been developed for the first time for separation from a smooth body. Previously a non-conical line-vortex model was implemented, however lack of representation of vorticity near the separation line limits the applicability of the results. The solution procedure for the non-conical problem consists of a downstream-marching scheme starting from a known solution at the nose. Starting solutions are available if the flow at the nose is assumed conical. With symmetry enforced, solutions have been calculated far downstream, however progress for asymmetric solutions has been more limited. In the asymmetric case the vortex sheet develops inflexions which cause the solution procedure to fail. The non-conical formulation also permitted a stability analysis to be carried out for conical line-vortex solutions, which show that where asymmetric solutions exist they are stable and the corresponding symmetric solutions are unstable. Dissert. Abstr.

N93-24243# Environmental Research Inst. of Michigan, Ann Arbor.
SAXON-FPN NAWC/ERIM P-3 SAR DATA DISTRIBUTION AND ANALYSIS Final Report, Oct. 1991 - Sep. 1992
CHRISTOPHER C. WACKERMAN 1 Nov. 1992 64 p
(Contract N00014-91-C-0207)
(AD-A259944; ERIM-240600-4-F) Avail: CASI HC A04/MF A01

As part of the SAXON-FPN Experiment, ERIM collected, processed and distributed SAR imagery from the ERIM/NAWC P-3 system. In addition we analyzed data collected in a spotlight mode to extract estimates of the real modulation transfer function. The report summarizes both activities, along with an analysis of the cross-channel coupling for cross-polarized data for the system. GRA

N93-24487# Aeritalia S.p.A., Pomigliano D'Arco (Italy). Viale dell'Aeronautica.
A METHOD FOR THE ANALYSIS OF COMPLEX CONFIGURATION THREE DIMENSIONAL INTERNAL VORTICES BASED ON THE SOLUTION OF EULER EQUATIONS [UN METODO PER L'ANALISI DI CAMPI TRIDIMENSIONALI VORTICOSI INTORNO A CONFIGURAZIONE COMPLESSE BASATO SULLA RISOLUZIONE DELLE EQUAZIONI DU EULERO]
A. AMENDOLA, R. TOGNACCINI, and P. L. VITAGLIANO 1989 11 p In ITALIAN Presented at Associazione Italiana di Aeronautica e Astronautica 10th Congresso Nazionale, Pisa, Italy, 16-20 Oct. 1989
(ETN-93-93701) Avail: CASI HC A03/MF A01

A computation program for subsonic and transonic analysis of complex aerodynamic configurations is presented. The flow model is based on Euler equations, and it is possible to introduce the propellor effect by means of boundary conditions (actuator disk model), so that the system is particularly suited to vortex fields. The software components are as follows: interactive graphics package for topological decomposition; computational grid generator; resolution of the equations of motion; and flow visualization. Application examples of industrially interesting configurations are presented, and future developments are outlined. ESA

N93-24531*# Lockheed-Georgia Co., Marietta.
EXPERIMENTAL STUDY OF THE SEPARATING CONFLUENT BOUNDARY-LAYER. VOLUME 2: EXPERIMENTAL DATA. APPENDICES A-E: DATA SUPPLEMENT (Diskette)
J. A. BRADEN, R. R. WHIPKEY, G. S. JONES, and D. E. LILLEY Mar. 1983 Diskette: IBM compatible 5.25-inch DSHD
(Contract NAS1-16028)
(NASA-CR-166018-SUPPL; NAS 1.26:166018-SUPPL; LG82ER0184-SUPPL; NONP-SUPPL-DK-93-159798) Avail: Issuing Activity (Center for AeroSpace Information) DK A01

A supplement to NASA document N84-20481 is presented in the form of appendices A, B, C, D, and E, which contain the

LV-derived boundary-layer and wake data for approximately 30,000 combinations of airfoil geometric locations and configurations in the form of velocity vectors, turbulence intensities, and Reynolds shear stresses. The appendices are provided on a floppy disk. The original document discussed an experimental low speed study of the separating confluent boundary layer on a NASA GAW-1 high lift airfoil. CASI

N93-24534*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN EXPERIMENTAL INVESTIGATION OF A SUPERCRITICAL AIRFOIL AT TRANSONIC SPEEDS (Diskette Supplement)
G. G. MATEER, H. L. SEEGMILLER, L. A. HAND, and J. SZODRUCH (Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen, Germany.) Jul. 1992 56 p Diskette supplement: IBM compatible 3.5-inch diskette in ASCII format
(Contract RTOP 505-59-40)
(NASA-TM-103933; A-92089; NAS 1.15:103933; NONP-SUPPL-DK-93-159801) Avail: Issuing Activity (Center for AeroSpace Information) HC/DK A09

Detailed experimental data were obtained on a supercritical airfoil and in the surrounding flowfield. Surface pressures were measured on both the model and wind-tunnel walls. The velocity field above the airfoil and the field in its wake was documented using a laser Doppler velocimeter. The data illustrate the effect of Mach number and angle of attack on the flow over the airfoil. Angles of attack ranged from 0.5 to 1.5 degrees and the Mach number was varied from 0.73 to 0.8. These variations were sufficient to provide separated and attached flows on the airfoil that were not time dependent. The profile drag was determined via non-intrusive measurements. The data are also on a 3.5-inch diskette included and are available though E-mail.
Author (revised)

N93-24561# Tecogen, Inc., Waltham, MA.
VARIABLE SPEED GAS ENGINE-DRIVEN AIR COMPRESSOR SYSTEM Final Technical Report, Oct. 1989 - Dec. 1991
J. R. MORGAN, A. E. RUGGLES, T. N. CHEN, and J. GEHRET Nov. 1992 247 p Sponsored by Gas Research Inst., Chicago, IL
(Contract GRI-5089-291-1846)
(PB93-147353; TR4489-010-92; GRI-92/0414) Avail: CASI HC A11/MF A03

Tecogen Inc. and Ingersoll-Rand Co. as a subcontractor have designed a nominal 150-hp gas engine-driven air compressor utilizing the TECODRIVE 8000 engine and the Ingersoll-Rand 178.5-mm twin screw compressor. Phase 1 included the system engineering and design, economic and applications studies, and a draft commercialization plan. Phase 2 included controls development, laboratory prototype construction, and performance testing. The testing conducted verified that the compressor meets all design specifications. GRA

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A93-30516
STRUCTURE AND EVOLUTION OF AN ISOLATED SEMI-GEOSTROPHIC CYCLONE
CHRISTOPH SCHAR (Washington Univ., Seattle) and HEINI WERNLI (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) Royal Meteorological Society, Quarterly Journal (ISSN 0035-9009) vol. 119, no. 509, pt. A Jan. 1993 p. 57-90. Research supported by SNSF refs
(Contract NSF ATM-89-14138; NSF ATM-91-06494)

Consideration is given to the evolution and structure of an idealized low-pressure system examined within the framework of the semigeostrophic dynamics and within the limit of uniform potential vorticity. Instead of studying the evolution of a longitudinally periodic train of baroclinic systems, an isolated cyclone is grown from suitably chosen initial conditions. It is shown that the resulting development is capable of producing a range of flow features that compare favorably with observationally based conceptual models of cyclogenesis. The evolving cycle is analyzed both from Lagrangian and Eulerian standpoints. The existence of Lagrangian criteria that allow for the objective definition of air-streams and flow patterns within developing cycles is shown.
P.D.

A93-31057#
THERMAL BATTERIES FOR AIRCRAFT EMERGENCY POWER
DAVID M. RYAN (USAF, Wright Lab., Wright-Patterson AFB, OH) Feb. 1993 7 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993
(AIAA PAPER 93-1189)

Thermal batteries are being proposed for the Emergency Power System for aircraft. Thermal batteries are a reserve type battery which is essentially inert until activated. Thermal batteries can generate full power in several seconds and nominally produce 20 WHr/lb and operate over a temperature range of -65 deg to 165 deg. Thermal batteries have a proven field storage life exceeding 25 years. They contain no liquids, can be maintained at any attitude, operate at any altitude, and do not leak any toxic or noxious materials. Expended thermal batteries contain no lead or cadmium and do not represent a significant disposal or environmental problem. Thermal batteries have a thirty year history of excellent performance providing on-board power for missiles and other weapons and have a proven safety record with no field injuries ever. Thermal batteries have a relatively low cost of initial ownership and require no maintenance. Author

A93-31345
CHARACTERIZATION OF THE PLANETARY BOUNDARY LAYER BY ACOUSTIC SOUNDING [CARATTERIZZAZIONE DELLO STRATO DI CONFINE PLANETARIO MEDIANTE SONDAGGIO ACUSTICO]
PAOLA FAGGIAN (Milano, Univ., Milan, Italy), ALBERTO LATINI (Aeronautica Militare Italiana, Servizio Meteorologico, Milan, Italy), and ERMANNO VECCIA (Aeronautica Militare Italiana, Servizio Meteorologico, Rome, Italy) Rivista di Meteorologia Aeronautica (ISSN 0035-6328) vol. 52, no. 1-2 Jan.-June 1992 p. 5-20. In Italian. refs

The planetary boundary layer (PBL) of Cameri airport has been defined using an up-to-date treatment of PBL theory together with sodar data and conventional data. The reliability of the sodar has been verified. Author

A93-31346
CHARACTERIZATION OF THE BREEZE REGIME AT CAMERI (NOVARA) AIRPORT BY ACOUSTIC SOUNDING [CARATTERIZZAZIONE DEL REGIME DI BREZZA SULL'AEROPORTO DI CAMERI /NOVARA/ MEDIANTE SONDAGGIO ACUSTICO]
PAOLA FAGGIAN (Milano, Univ., Milan, Italy), SERGIO FIACCONI, and ERMANNO VECCIA (Aeronautica Militare Italiana, Servizio Meteorologico, Milan, Italy) Rivista di Meteorologia Aeronautica (ISSN 0035-6328) vol. 52, no. 1-2 Jan.-June 1992 p. 47-54. In Italian. refs

The characterization of the breeze regime at Cameri (Novara) airport were determined using sodar wind measurement. Sodar observations have been studied for more than two years at the Regional Meteorological Center of Milano-Linate. Author

A93-31779* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ASSESSMENT OF MICROBURST MODELS FOR DOWNDRAFT ESTIMATION
DAN D. VICROY (NASA, Langley Research Center, Hampton,

VA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1043-1048. AIAA Flight Simulation Technologies Conference, New Orleans, LA, Aug. 12-14, 1991, Technical Papers, p. 300-309. Previously cited in issue 20, p. 3492, Accession no. A91-47833 refs
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A93-31783
SONIC BOOM ENVIRONMENT UNDER A SUPERSONIC MILITARY OPERATING AREA
KENNETH J. PLOTKIN, VIJAY R. DESAI, MICHAEL J. LICAS, CAREY L. MOULTON (Wyle Labs., Arlington, VA), and RUBEN G. GARZA (Geo-Marine, Inc., Plano, TX) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1069-1072. AIAA, Aeroacoustics Conference, 13th, Tallahassee, FL, Oct. 22-24, 1990, AIAA Paper 90-4032. Previously cited in issue 02, p. 204, Accession no. A91-12541 Research supported by USAF refs
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A93-31906
HIGH ICE CRYSTAL PRODUCTION IN WINTER CUMULI OVER THE JAPAN SEA
TSUTOMU TAKAHASHI (Kyushu Univ., Fukuoka, Japan) Geophysical Research Letters (ISSN 0094-8276) vol. 20, no. 6 March 19, 1993 p. 451-454. Research supported by MOESC refs
Copyright
Winter cumulus clouds that develop over the Sea of Japan contain ice crystals in concentrations of the order of 200/l, even though the cloudtop temperature is not less than -20 C. An aircraft equipped with a novel video camera for ice-crystal counting was flows into winter cumulus clouds that develop over the Sea of Japan in typical Monsoon weather. The very high concentration of ice crystals noted in the 60-100 micron diameter range is noted to involve small and large graupel, while medium-sized graupel is missing. O.C.

A93-31943
WAVELET ANALYSIS OF GUST STRUCTURE IN MEASURED ATMOSPHERIC TURBULENCE DATA
J. G. JONES, G. W. FOSTER, and P. G. EARWICKER (Royal Aerospace Establishment, Farnborough, United Kingdom) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 94-99. AIAA, Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7-10, 1991, AIAA Paper 91-0448. Previously cited in issue 06, p. 900, Accession no. A91-19305 refs
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A93-32381* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ELECTRIC FIELD MEASUREMENTS WITH AN AIRPLANE - PROBLEMS CAUSED BY EMITTED CHARGE
J. J. JONES, W. P. WINN, and F. HAN (New Mexico Inst. of Mining and Technology, Socorro) Journal of Geophysical Research (ISSN 0148-0227) vol. 98, no. D3 March 20, 1993 p. 5235-5244. Research supported by USAF refs
(Contract NAG8-751; NSF ATM-82-05468; NSF ATM-82-18621; NSF ATM-86-00526; NSF ATM-89-19697; NSF ATM-91-06755)
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The temporal variation of electric field components deduced from measurements made with airplanes penetrating electrified clouds is often complex, especially when the airplane experiences strong electrical charging. However, unusually simple electric field variations were obtained for penetrations involving severe charging of an airplane on flights over Kennedy Space Center, Florida, on August 19, 1989. Analysis of these results suggests that plumes of ions were emitted from the airplane. The electric field from these plumes was more intense than the ambient field from the cloud at the location of the aft electric field sensor. As a consequence, the deduced component of the ambient electric field in the direction of flight was severely distorted. These findings emphasize (1) the importance of careful evaluation of electric field data obtained with airplanes and (2) the need for improved measurements. Author (revised)

N93-22334# Midwest Research Inst., Golden, CO.
FULL VECTOR (3-D) INFLOW SIMULATION IN NATURAL AND WIND FARM ENVIRONMENTS USING AN EXPANDED VERSION OF THE SNLWIND (VEERS) TURBULENCE CODE
N. D. KELLEY Nov. 1992 10 p Presented at the 12th American Society Mechanical Engineers Wind Energy Symposium, Houston, TX, 31 Jan. - 4 Feb. 1993
(Contract DE-AC02-83CH-10093)
(DE93-000041; NREL/TP-442-5225; CONF-930153-2) Avail: CASI HC A02/MF A01
We have recently expanded the numerical turbulence simulation (SNLWIND) developed by Veers to include all three components of the turbulent wind vector. We have also configured the code to simulate the characteristics of turbulent wind fields upwind and downwind of a large wind farm, as well as over uniform, flat terrain. Veers's original method only simulates the longitudinal component of the wind in neutral flow. This paper overviews the development of spectral distribution, spatial coherence, and cross correlation models used to expired the SNLWIND code to include the three components of the turbulent wind over a range of atmospheric stabilities. These models are based on extensive measurements of the turbulence characteristics immediately upwind and downwind of a large wind farm in San Gorgonio Pass, California. DOE

N93-22387*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ROWS WAVE SPECTRAL DATA COLLECTED IN SAXON-FPN, NOVEMBER 1990
F. JACKSON, D. VANDEMARK, S. BAILEY, C. VAUGHN, D. HINES, J. WARD (Computer Sciences Corp., Wallops Island, VA.), K. STEWART (Computer Sciences Corp., Wallops Island, VA.), and B. CHAPRON (SM Systems and Research Corp., Landover, MD.) Washington Apr. 1993 64 p
(Contract N00173-80-WR-00281)
(NASA-TM-104582; NAS 1.15:104582; REPT-93B00064) Avail: CASI HC A04/MF A01
High-resolution directional wave spectra obtained with the NASA Ku-band radar ocean wave spectrometer (ROWS) on the Naval Research Laboratory P-3 aircraft during SAXON-FPN (SAR and X-Band Ocean Nonlinearities Experiment-Forschungsplattform Nordsee) experiments in the North Sea in November 1990 are presented. This experiment was the first in which the ROWS was operated with its new pc-based high-speed digital data acquisition system. Author

N93-22805# Technical Research Centre of Finland, Espoo.
EXHAUST EMISSIONS FROM DIESEL ENGINES [DIESELMOOTTORIEN PAKOKAASUPAASTOT]
JUHANI LAURIKKO 1992 51 p In FINNISH
(DE93-752852; VTT-JULK-761) Avail: CASI HC A04/MF A01
The amount and composition of exhaust emissions from diesel engines at cold-start and before reaching the normal running temperature were determined. Both direct injection and prechamber-type high-speed engines were studied. Experiments were carried out in the temperature range of (+)20 to (-)30 C, applying both constant and cyclic load during a half-an-hour test period. Emission test were also performed with the direct injection engine in accordance with the ECE R-49 regulation by keeping the engine at the running temperature and the ambient temperature lower than normal. All diesel fuels commercially available in Finland and one jet engine fuel, which is also suited for diesel engines, were used in the experiment. The measuring results indicated that the exhaust gas emissions from the direct injection engine change more than those from the precombustion chamber engine when the start-up and running temperatures decline. These differences may be due to differences in combustion chamber types. In the direct injection engine the emissions of carbon monoxide (CO) and unburnt hydrocarbons (HC) were increased by the decline in the start-up temperature, while the start-up temperature had only a minor effect on nitrogen oxide (NO(x)) emissions. There were

only insignificant differences between the tested fuel grades. The low ambient temperature also affected the emissions of the warmed-up engine. The CO and HC emissions increased, dependent on the fuel used, 1.2 to 1.5-fold compared to those measured at a normal temperature, while the NO(x) emissions remained practically unchanged. In the direct injection engine, the formation of so-called white smoke was found to be intensive after the cold start-up. DOE

N93-23045# Federal Aviation Administration, Atlantic City, NJ.
PLAN FOR THE EVALUATION OF THE PROTOTYPE TERMINAL DOPPLER WEATHER RADAR (TDWR) SYSTEM
BAXTER R. STRETCHER Feb. 1993 22 p
(DOT/FAA/CT-TN92/44) Avail: CASI HC A03/MF A01

The purpose of this plan is to detail the procedural approach and methods to be employed in evaluating the air traffic control (ATC) interface of the prototype Terminal Doppler Weather Radar (TDWR) system. The plan describes the evaluation that will be performed at the Orlando International Airport (MCO) during the summer of 1992. The Federal Aviation Administration (FAA) Technical Center will be interested in the controller's and supervisor's evaluation of the Geographical Situation Display (GSD) and the Ribbon Display Terminal (RDT), installed at the ATC tower. The evaluation of these displays may determine the operational suitability of the TDWR in the National Airspace System (NAS). Author

N93-23057*# National Aeronautics and Space Administration, Washington, DC.
***THE ATMOSPHERIC EFFECTS OF STRATOSPHERIC AIRCRAFT* Report No. 2**
RICHARD S. STOLARSKI, ed. (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.) and HOWARD L. WESOKY, ed. Mar. 1993 220 p
(NASA-RP-1293; NAS 1.61:1293) Avail: CASI HC A10/MF A03

This document presents a second report from the Atmospheric Effects of Stratospheric Aircraft (AESA) component of NASA's High-Speed Research Program (HSRP). This document presents a second report from the Atmospheric Effects of Stratospheric Aircraft (AESA) component of NASA's High Speed Research Program (HSRP). Market and technology considerations continue to provide an impetus for high-speed civil transport research. A recent United Nations Environment Program scientific assessment has shown that considerable uncertainty still exists about the possible impact of aircraft on the atmosphere. The AESA was designed to develop the body of scientific knowledge necessary for the evaluation of the impact of stratospheric aircraft on the atmosphere. The first Program report presented the basic objectives and plans for AESA. This second report presents the status of the ongoing research as reported by the principal investigators at the second annual AESA Program meeting in May 1992: Laboratory studies are probing the mechanism responsible for many of the heterogeneous reactions that occur on stratospheric particles. Understanding how the atmosphere redistributes aircraft exhaust is critical to our knowing where the perturbed air will go and for how long it will remain in the stratosphere. The assessment of fleet effects is dependent on the ability to develop scenarios which correctly simulate fleet operations. Author (revised)

N93-23064# Federal Aviation Administration, Atlantic City, NJ.
AIR TRAFFIC OPERATIONAL EVALUATION PLAN FOR THE PROTOTYPE AIRPORT SURVEILLANCE RADAR WIND SHEAR PROCESSOR (ASR-WSP) AT ORLANDO INTERNATIONAL AIRPORT
RADAME MARTINEZ Feb. 1993 17 p
(DOT/FAA/CT-TN92/45) Avail: CASI HC A03/MF A01

The Airport Surveillance Radar Wind Shear Processor (ASR-WSP) (also known as Airport Surveillance Radar-9 (ASR-9) modification for low altitude wind shear detection) is a production ASR-9 with an expanded weather channel for added processing capabilities. The primary mission of the ASR-WSP is to enhance the safety of air travel through the timely detection and reporting of hazardous wind shear in and near the terminal approach and departure zones of the airport. It will also improve the management of air traffic (AT) in the terminal area through the forecast of precipitation, and ultimately the detection of other hazardous weather phenomena. The ASW-WSP may be used as a stand-alone system at airports without a Terminal Doppler Weather Radar (TDWR) or Enhanced-Low Level Wind Shear Alert System (E-LLWAS), or in an integrated mode with either, or both, the TDWR and E-LLWAS. This plan outlines the Federal Aviation Administration's (FAA) operational evaluation of an ASR-WSP which will operate at Orlando International Airport (MCQ) during the summer of 1992. Data will be collected via questionnaires completed by air traffic controllers and supervisors. The results of the evaluation will be analyzed and any necessary changes will be made prior to full production. Author

N93-23232# National Center for Atmospheric Research, Boulder, CO. Research Aviation Facility.
THEORETICAL ERRORS ON AIRBORNE MEASUREMENTS OF: STATIC PRESSURE, IMPACT TEMPERATURE, AIR FLOW ANGLE, AIR FLOW SPEED
PHILIPPE NACASS Nov. 1992 75 p Sponsored by National Science Foundation, Washington, DC
(PB93-136406; NCAR/TN-385+STR) Avail: CASI HC A04/MF A01

The measurement of the surface pressure distribution on the nose of an aircraft (Brown et al, 1983) from which the dynamic pressure and angles of attack and sideslip can be obtained, defines the velocity vector of the aircraft relative to the atmosphere. In this report, a complete theory development gives an exact calculation for all angles with irrotational flow around a sphere, the easiest shape for a nose radome. But when a hemisphere is fixed on a long cylindrical portion the calculations of overspeed and pressure coefficient of the whole sphere are only approximations. Thus, an error is made in the measurements of the surface pressure distribution on the aircraft radome and on the angles of attack and sideslip. Most authors consider that the pressure coefficient is equal to zero on inlet sensors. GRA

N93-23983# Army Aeromedical Research Lab., Fort Rucker, AL.
SOLAR-POWERED LIGHT EMITTING DIODE POWER LINE AVOIDANCE MARKER DESIGN Final Report
ELLEN H. SNOOK, CLARENCE E. RASH, JOHN S. MARTIN, RICHARD R. LEVINE, and PARLEY P. JOHNSON Dec. 1992 33 p
(AD-A259886; USAARL-93-6) Avail: CASI HC A03/MF A01

In-flight wire strikes are a constant threat to U.S. Army Aviation during all-weather, daytime and nighttime helicopter operations. Despite routine training on wire avoidance techniques, wire strikes continue to occur, with a majority of the mishaps historically occurring during training and maneuvering over familiar sites. In an effort to increase the conspicuity of suspended cables and wires, the aviation training community at Fort Rucker, Alabama, currently employs a passive wire marking system which consists of international-orange colored spheres suspended from cables and wires in heavily trafficked airspace. During a previous evaluation of wire marker visibility, a solar-powered wire marker design was developed. This new design incorporates retroreflective material and light emitting diodes (LED's) to provide greater range visibility and detectability during aided and unaided flight. GRA

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A93-30508
MODELING, ESTIMATION AND CONTROL OF SYSTEMS WITH UNCERTAINTY
GIOVANNI B. DI MASI, ED. (Padova, Univ.; CNR, LADSEB, Padua, Italy), ANDREA GOMBANI, ED. (CNR, LADSEB, Padua, Italy), and ALEXANDER B. KURZHANSKY, ED. (International Inst. for Systems Analysis, Laxenburg, Austria) Boston, MA Birkhaeuser (Progress in Systems and Control Theory. Vol. 10) 1991 474 p.
(ISBN 0-8176-3580-7) Copyright

Various papers on modeling, estimation, and control of systems with uncertainty are presented. Individual topics addressed include: feedback controls for uncertain systems, inner-unstable factorization of stable rational transfer functions, multivariable adaptive control with least squares parameter estimates, stabilization of uncertain linear systems, identification of linear systems from noisy data, adaptive control of a partially observable stochastic system, balancing and Hankel operators, system identification from an arbitrary observed impulse response, assessing model quality from data, stable graphs of multifunctions in conflict-controlled systems. Also discussed are: optimal control of singularly perturbed stochastic differential equations, controller and observer design for cubic systems, separation principle in guaranteed control, robust stability of linear dynamic systems, control synthesis for uncertain systems, aircraft control during takeoff in wind shear, limit behavior of attainable and superattainable sets, target problem and viability kernels, discontinuous optical control, approximate modeling by orthonormal functions. (No individual items are abstracted in this volume) C.D.

A93-30979#
SCHEDULED MAINTENANCE OPTIMIZATION SYSTEM
RAYMOND J. ANDERSON (McDonnell Douglas Aerospace, Saint Louis, MO) Feb. 1993 8 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Research supported by McDonnell Douglas Aerospace
(AIAA PAPER 93-1090) Copyright

This paper discusses work directed toward developing a user friendly automated system to provide scheduled maintenance optimization of weapon systems. MDA Independent Research and Development (IRAD) has studied scheduled maintenance requirements of fighter aircraft and have investigated technology insertions for reducing and burden. Information gathered has been documented and stored in a database system for ease of access and updating. Modules were developed for addressing the major components of the scheduled maintenance requirements development. Author

A93-31134
PSEUDOPOLYNOMIAL METHOD OF DISCRETE OPTIMIZATION AND ITS APPLICATION TO THE AUTOMATION OF TECHNOLOGICAL PROCESS DESIGN [PSEVDOPOLINOMIAL'NYI METOD DISKRETNOI OPTIMIZATSII I EGO PRIMENENIE DLIA AVTOMATIZATSII PROEKTIROVANIIA TEKHNOLOGICHESKIKH PROTSESSOV]
A. V. GUSEV, A. V. PODZEI, and G. Z. SEREBRENNIKOV *In* Progressive fabrication processes in aircraft-engine production Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 41-49. In Russian. refs
Copyright

A93-31140
INTELLIGENT SYSTEMS [INTELLEKTUAL'NYE SISTEMY]
V. V. MALYSHEV, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 104 p. In Russian.
Copyright

Papers are presented on a multilevel intelligent system of flight-vehicle control, the selection of models in the problem of predicting navigation-system errors, a core for intelligent systems called IKAR, and the design of a logic output machine for production systems with fuzzy knowledge. Consideration is also given to expert systems for the structural synthesis of multiprocessor controllers and real-time computing devices and to VLSI design for self-testing and self-recoverable intelligent systems. (For individual items see A93-31141 to A93-31146) L.M.

A93-31141
A MULTILEVEL INTELLIGENT SYSTEM FOR FLIGHT-VEHICLE CONTROL [MNOGOUROVNEVAIA INTELLEKTUAL'NAIA SISTEMA UPRAVLENIIA LETATEL'NYM APPARATOM]
N. N. ANDRONOV, V. A. GORELOV, L. A. KOVZAN, V. E. KRAIZMAN, G. N. LEBEDEV, and V. V. PODAFEI *In* Intelligent systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 5-11. In Russian. refs
Copyright

A three-level intelligent system for flight-vehicle control is described. The first level describes the logical scenario; the second level, the quantitative one, is realized using an expert system; and the third level addresses the question of changes in the behavioral strategy of the system during the appearance of unforeseen situations (e.g., a maneuver). L.M.

A93-31143
MATHEMATICAL MODELING OF THE MOTIONS OF A VEHICLE AS A WHOLE AND THE CONTROL OF THE VEHICLE [O MATEMATICHESKOM MODELIROVANII DVIZHENII OB'EKTA V TSELOM I UPRAVLENIIA IM]
L. G. RAIKOV *In* Intelligent systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 24-28. In Russian. refs
Copyright

An approach to flight-vehicle motion modeling is presented where the vehicle is represented by a set of programs for calculating the mechanical motion of the mass center of the vehicle and the motions of a deformable body with respect to the mass center, various structural vibrations of the vehicle, its motion stability, the motions of various media near the vehicle, and the interaction of the media with the vehicle. The proposed mathematical approach, uniting concepts of mechanics and control theory, makes it possible to study the vehicle as a whole. L.M.

A93-31145
THE CONCEPT OF A FLIGHT-VEHICLE COMPUTING COMPLEX [KONTSEPTSIIA VYCHISLITEL'NOGO KOMPLEKSA LETATEL'NOGO APPARATA]
G. T. ARTAMONOV and V. D. TIURIN *In* Intelligent systems Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 49-60. In Russian.
Copyright

The concept of a flight-vehicle computing complex with artificial-intelligence elements is described which is based on the idea of modular asynchronous developable systems. The computing tools forming the complex constitute a hierarchical system containing at least five levels corresponding to generalized functional tasks. The architecture of this system is described. The main means to high system efficiency is parallel processing at all levels and all stages of program execution. L.M.

A93-31180
DEVELOPMENT AND OPERATION OF A CAD SYSTEM FOR AIRCRAFT GAS TURBINE ENGINES USING THE PARUS TOOL SYSTEM [RAZRABOTKA I FUNKTSIONIROVANIE SAPR AVIATSIONNYKH GTD S POMOSHCH'IU KOMPLEKSA INSTRUMENTAL'NYKH SREDSTV 'PARUS']

V. B. LOMAKIN, V. G. MASLOV, S. G. POPOV, and I. V. KHRISTENKO Aviatsionnaia Tekhnika (ISSN 0579-2975) no. 3 1992 p. 108-111. In Russian. refs
Copyright

The general structure and implementation of a flexible open-architecture CAD system for the design of aircraft gas turbine engines is described which is controlled by a specially developed set of tools, PARUS. The functions, capabilities, and technical specifications of the subsystems of the PARUS tool system are briefly characterized. A block diagram of the PARUS system is included. V.L.

A93-31958
SPECIAL ROTATION VECTORS - A MEANS FOR TRANSMITTING QUATERNIONS IN THREE COMPONENTS
AMMON KATZ (Alabama Univ., Tuscaloosa) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 148-150. Abridged. AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers, p. 261-266. *Previously cited in issue 22, p. 3998, Accession no.* A92-52454 refs
Copyright

A93-32001* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NONLINEAR SMOOTHING IDENTIFICATION ALGORITHM WITH APPLICATION TO DATA CONSISTENCY CHECKS
M. IDAN (Technion - Israel Inst. of Technology, Haifa) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 16, no. 2 Mar.-Apr. 1993 p. 337-345. Research supported by Advanced Rotorcraft Technology, Inc. refs
(Contract NAG2-106)
Copyright

A parameter identification algorithm for nonlinear systems is presented. It is based on smoothing test data with successively improved sets of model parameters. The smoothing, which is iterative, provides all of the information needed to compute the gradients of the smoothing performance measure with respect to the parameters. The parameters are updated using a quasi-Newton procedure, until convergence is achieved. The advantage of this algorithm over standard maximum likelihood identification algorithms is the computational savings in calculating the gradient. This algorithm was used for flight-test data consistency checks based on a nonlinear model of aircraft kinematics. Measurement biases and scale factors were identified. The advantages of the presented algorithm and model are discussed. Author

A93-32140
OPTIMAL CONTROL WITH ADAPTATION OF THE EXTRAPOLATION TIME [OPTIMAL'NOE UPRAVLENIE S ADAPTATSIEI VREMENI EKSTRAPOLIATSII]
A. A. KRASOVSKII (Voenno-Vozdushnaia Inzhenernaia Akademiia, Moscow, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310) no. 2 Feb. 1993 p. 148-157. In Russian. refs
Copyright

A new class of adaptive controllers optimal with respect to the generalized work functional is examined. The controllers feature automatic variation of the sliding interval, T, of prediction (extrapolation) of the free motion of the plant. Two versions of the algorithm are examined which are based on the current search for an optimal T value. The wide range of applicability, high stability of the adaptation processes, and simplicity of the software support of this class of controllers are demonstrated. AIAA

A93-32172
APPROXIMATION OF SOLUTIONS TO DIFFERENTIAL EQUATIONS AND CONVERGENCE OF THE GALERKIN METHOD [APPROKSIMATSIIA RESHENII DIFFERENTSIAL'NYKH URAVNENII I SKHODIMOST' METODA GALERKINA]
I. I. KUTYSH *In* Gas dynamics of jet engine components Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 91-97. In Russian. refs
Copyright

The use of the Galerkin method for solving differential equation is discussed, and the advantages of the Galerkin approximation over difference methods are examined. Some important details relating to the use of the Galerkin method for the approximation of solutions to differential equations are considered. Results of an analysis of the convergence of the method are presented. AIAA

A93-32209
OPTIMIZATION OF THE STRUCTURES AND PARAMETERS OF THE AUTOMATIC CONTROL SYSTEMS OF FLIGHT VEHICLES [OPTIMIZATSIIA STRUKTUR I PARAMETROV SISTEM AVTOMATICHESKOGO UPRAVLENIIA LETATEL'NYMI APPARATAMI]
M. N. KRASIL'SHCHIKOV, ED. Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 60 p. In Russian. For individual items see A93-32210 to A93-32217
Copyright

The papers contained in this volume focus on the theoretical and applied aspects of the optimization of the structures and parameters of the automatic control systems of flight vehicles. Some of the papers present theoretical results related to the derivation of the necessary and sufficient conditions for the existence of optimal controls for certain classes of systems. Control algorithms for various classes of plants are discussed, controller parameters are optimized. Algorithms are also presented for estimating the coordinates and parameters of dynamic systems functioning in the presence of random factors and uncertainties of different kinds. Theoretical concepts are illustrated by modeling results. AIAA

A93-32215
DETERMINATION OF THE CONTROL MOMENT VECTOR FROM THE CONDITION OF THE MINIMUM OF THE QUADRATIC QUALITY INDEX [OPREDELENIE VEKTORA UPRAVLIAIUSHCHIKH MOMENTOV IZ USLOVIIA MINIMUMA KVADRATICHNOGO POKAZATELIA KACHESTVA]
E. I. MITROSHIN and A. I. ZAVEDEEV *In* Optimization of the structures and parameters of the automatic control systems of flight vehicles Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 39-43. In Russian. refs
Copyright

The orientation of a coupled coordinate system with respect to the inertial coordinates of a flight vehicle is described by an expression where the matrix of direction cosines is expressed in terms of kinematic parameters. A bilinear orthogonal equation is written which relates the kinematic parameters. The control moment vector of electromechanical inertial engines, which satisfies the bilinear equation and the state equation, is determined on the basis of the condition of the minimum of a quadratic quality index. AIAA

A93-32240
FLOWS VISUALIZED WITH HIGHEND - A PROGRAM SYSTEM FOR FAST AND INTERACTIVE DATA PROCESSING [STROEMUNGEN SICHTBAR MIT HIGHEND - EIN PROGRAMMSYSTEM FUER SCHNELLE UND INTERAKTIVE DATENAUSWERTUNGEN]
HANS-GEORG PAGENDARM, MONIKA HANNEMANN, BIRGIT WALTER, and BIRGIT SEITZ (DLR, Inst. fuer Theoretische Stroemungmechanik, Goettingen, Germany) DLR-Nachrichten (ISSN 0937-0420) no. 70 Feb. 1993 p. 9-13. In German.
Copyright

A new software package for data processing in flow simulations called HIGHEND (HIGHEND Interactive Graphics system for Hierarchical Experimental and Numerical Data) is described. HIGHEND is a pure postprocessing software system with modular architecture. The HIGHEND graphics and architecture and the user friendliness of HIGHEND are discussed. Examples of HIGHEND applications are given. AIAA

A93-32621 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
IMPLICIT SOLVERS FOR UNSTRUCTURED MESHES
V. VENKATAKRISHNAN (Computer Sciences Corp.; NASA, Ames Research Center, Moffett Field, CA) and DIMITRI J. MAVRIPLIS (ICASE; NASA, Langley Research Center, Hampton, VA) Journal of Computational Physics (ISSN 0021-9991) vol. 105, no. 1 March 1993 p. 83-91. AIAA Computational Fluid Dynamics Conference, 10th, Honolulu, HI, June 24-27, 1991, Technical Papers, p. 115-124. Previously cited in issue 17, p. 2847, Accession no. A91-40712 refs
(Contract NAS2-12961; NAS1-18605)
Copyright

A93-32703* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STRUCTURED BACKGROUND GRIDS FOR GENERATION OF UNSTRUCTURED GRIDS BY ADVANCING-FRONT METHOD
SHAHYAR PIRZADEH (Vigyan, Inc., Hampton, VA) AIAA Journal (ISSN 0001-1452) vol. 31, no. 2 Feb. 1993 p. 257-265. AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1, p. 259-268. Previously cited in issue 23, p. 4129, Accession no. A91-53750 refs
(Contract NAS1-18585)
Copyright

A93-33083* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INS INTEGRATED MOTION ANALYSIS FOR AUTONOMOUS VEHICLE NAVIGATION
BARRY ROBERTS and MIKE BAZAKOS (Honeywell Systems and Research Center, Minneapolis, MN) *In* Image understanding for aerospace applications; Proceedings of the Meeting, Munich, Germany, June 13, 14, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 2-13. refs
(Contract NAS2-12800)
Copyright

The use of inertial navigation system (INS) measurements to enhance the quality and robustness of motion analysis techniques used for obstacle detection is discussed with particular reference to autonomous vehicle navigation. The approach to obstacle detection used here employs motion analysis of imagery generated by a passive sensor. Motion analysis of imagery obtained during vehicle travel is used to generate range measurements to points within the field of view of the sensor, which can then be used to provide obstacle detection. Results obtained with an INS integrated motion analysis approach are reviewed. AIAA

A93-33126* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
APPLICATIONS OF ARTIFICIAL INTELLIGENCE 1993: KNOWLEDGE-BASED SYSTEMS IN AEROSPACE AND INDUSTRY; PROCEEDINGS OF THE MEETING, ORLANDO, FL, APR. 13-15, 1993
USAMA M. FAYYAD, ED. (JPL, Pasadena, CA) and RAMASAMY UTHURUSAMY, ED. (GM Research Labs., Warren, MI) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1963) 1993 365 p. For individual items see A93-33127 to A93-33152
(SPIE-1963; ISBN 0-8194-1199-X) Copyright

The present volume on applications of artificial intelligence with regard to knowledge-based systems in aerospace and industry discusses machine learning and clustering, expert systems and optimization techniques, monitoring and diagnosis, and automated design and expert systems. Attention is given to the integration of AI reasoning systems and hardware description languages, care-based reasoning, knowledge, retrieval, and training systems, and scheduling and planning. Topics addressed include the preprocessing of remotely sensed data for efficient analysis and classification, autonomous agents as air combat simulation adversaries, intelligent data presentation for real-time spacecraft monitoring, and an integrated reasoner for diagnosis in satellite control. Also discussed are a knowledge-based system for the design of heat exchangers, reuse of design information for model-based diagnosis, automatic compilation of expert systems, and a case-based approach to handling aircraft malfunctions. AIAA

A93-33128* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SYSTEM DIAGNOSTIC BUILDER - A RULE GENERATION TOOL FOR EXPERT SYSTEMS THAT DO INTELLIGENT DATA EVALUATION
JOSEPH NIETEN (GHG Corp., Houston, TX) and ROGER BURKE (NASA, Johnson Space Center, Houston, TX) *In* Applications of artificial intelligence 1993: Knowledge-based systems in aerospace and industry; Proceedings of the Meeting, Orlando, FL, Apr. 13-15, 1993 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 31-38. refs
Copyright

Consideration is given to the System Diagnostic Builder (SDB), an automated knowledge acquisition tool using state-of-the-art AI technologies. The SDB employs an inductive machine learning technique to generate rules from data sets that are classified by a subject matter expert. Thus, data are captured from the subject system, classified, and used to drive the rule generation process. These rule bases are used to represent the observable behavior of the subject system, and to represent knowledge about this system. The knowledge bases captured from the Shuttle Mission Simulator can be used as black box simulations by the Intelligent Computer Aided Training devices. The SDB can also be used to construct knowledge bases for the process control industry, such as chemical production or oil and gas production. AIAA

A93-33143
MULTILEVEL CAUSAL-PROCESS MODELING - BRIDGING THE PLAN, EXECUTION, AND DEVICE-IMPLEMENTATION GAPS
KEITH LEVI (Maharishi International Univ., Fairfield, IA), DALE MOBERG (Ohio State Univ., Columbus), CHRISTOPHER MILLER, and FRED ROSE (Honeywell, Inc., Minneapolis, MN) *In* Applications of artificial intelligence 1993: Knowledge-based systems in aerospace and industry; Proceedings of the Meeting, Orlando, FL, Apr. 13-15, 1993 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 240-250. Research supported by DARPA refs
(Contract F33615-88-C-1739; F49620-89-C-0110)
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A preliminary investigation of whether an AI high-level mission performance model can usefully connect to and share information with a low-level VHSIC Hardware Description Language (VHDL) model of hardware components is reported. An example of a connection between such systems as the Pilot's Associate and Learning Systems for Pilot Aiding systems, and a system-level VHDL model of a graphics display processor, the Cockpit Display Generator, using functional representation, is shown. An example in which information for the emission performance model is obtained from a VHDL device model and another example in which testbench parameters for the VHDL model can be generated from the mission performance model are also described. AIAA

A93-33146* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CASE-BASED APPROACH TO HANDLING AIRCRAFT MALFUNCTIONS
STAMOS T. KARAMOUZIS and STEFAN FEYOCK (College of William and Mary, Williamsburg, VA) *In* Applications of artificial intelligence 1993: Knowledge-based systems in aerospace and industry; Proceedings of the Meeting, Orlando, FL, Apr. 13-15, 1993 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 274-284. refs
(Contract NCC1-159)
Copyright

Reasoning about physical systems in operation is a difficult task, and any attempt to automate the process must overcome the problems of modeling normal behavior, diagnosing faults, and predicting future behavior. This paper describes a prototypical

case-based reasoner (CBR) that operates in the domain of in-flight fault diagnosis and prognosis of aviation subsystems, particularly jet engines. The reasoner operates on the observation that the ability of a CBR program to reason about physical systems can be significantly enhanced by the addition to the CBR program of a model of the physical system to describe the system's structural, functional, and causal behavior. Author

A93-33148
A PRACTICAL AND GENERALIZABLE ARCHITECTURE FOR AN INTELLIGENT TUTORING SYSTEM
RANDY M. KAPLAN and HARRIET TRENHOLM (Educational Testing Service, Princeton, NJ) *In* Applications of artificial intelligence 1993: Knowledge-based systems in aerospace and industry; Proceedings of the Meeting, Orlando, FL, Apr. 13-15, 1993 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1993 p. 294-302. Research supported by USAF refs
Copyright

We describe an intelligent tutoring system called HYDRIVE (Hydraulics Interactive Video Experience). This system is built using several novel approaches to intelligent tutoring. The underlying rationale for HYDRIVE is based on the results of a cognitive task analysis. The reasoning component of the system makes extensive use of a hierarchical knowledge representation. Reasoning within the system is accomplished using a logic-based approach and is linked to a highly interactive interface using multimedia. The knowledge representation contains information that drives the multimedia elements of the system, and the reasoning components select the appropriate information to assess student knowledge or guide the student at any particular moment. As this system will be deployed throughout the Air Force maintenance function, the implementation platform is the IBM PC. Author (revised)

N93-22185*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN ARTIFICIAL INTELLIGENCE-BASED STRUCTURAL HEALTH MONITORING SYSTEM FOR AGING AIRCRAFT
JOSEPH E. GRADY, STANLEY S. TANG (Structural Integrity Associates, Inc., San Jose, CA.), and K. L. CHEN (Structural Integrity Associates, Inc., San Jose, CA.) *In* NASA, Washington, Technology 2002: The Third National Technology Transfer Conference and Exposition, Volume 2 p 343-351 Feb. 1993
Avail: CASI HC A02/MF A04

To reduce operating expenses, airlines are now using the existing fleets of commercial aircraft well beyond their originally anticipated service lives. The repair and maintenance of these 'aging aircraft' has therefore become a critical safety issue, both to the airlines and the Federal Aviation Administration. This paper presents the results of an innovative research program to develop a structural monitoring system that will be used to evaluate the integrity of in-service aerospace structural components. Currently in the final phase of its development, this monitoring system will indicate when repair or maintenance of a damaged structural component is necessary. Author

N93-22205* Computer Software Management and Information Center, Athens, GA.
COSMIC SOFTWARE CATALOG, 1993 Annual Report
1993 472 p
(NASA-CR-191005; NAS 1.26:191005) Avail: Issuing Activity (COSMIC, Athens, GA 30602-4272)

Descriptions of the software supplied by NASA's Computer Software Management and Information Center is included. Abstracts for over 1200 NASA-sponsored computer programs are included. Topics covered include the following: aeronautics, astronautics, chemistry and materials, engineering, geosciences, life sciences, mathematical and computer sciences, social sciences, and space sciences. Author (revised)

N93-22351*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PROCEEDINGS OF THE THIRD INTERNATIONAL WORKSHOP ON NEURAL NETWORKS AND FUZZY LOGIC, VOLUME 1
CHRISTOPHER J. CULBERT, ed. Jan. 1993 211 p Workshop held in Houston, TX, 1-3 Jun. 1992 Sponsored in part by Houston Univ.
(NASA-CP-10111-VOL-1; S-701-VOL-1; NAS 1.55:10111-VOL-1)
Avail: CASI HC A10/MF A03

Documented here are papers presented at the Neural Networks and Fuzzy Logic Workshop sponsored by the National Aeronautics and Space Administration and cosponsored by the University of Houston, Clear Lake. The workshop was held June 1-3, 1992 at the Lyndon B. Johnson Space Center in Houston, Texas. During the three days approximately 50 papers were presented. Technical topics addressed included adaptive systems; learning algorithms; network architectures; vision; robotics; neurobiological connections; speech recognition and synthesis; fuzzy set theory and application, control, and dynamics processing; space applications; fuzzy logic and neural network computers; approximate reasoning; and multiobject decision making.

N93-22366*# Tokyo Inst. of Tech., Yokahama (Japan). Dept. of Systems Science.
FUZZY CONTROL OF AN UNMANNED HELICOPTER Abstract Only
M. SUGENO, J. NISHINO, and H. MIWA *In* NASA. Johnson Space Center, Proceedings of the Third International Workshop on Neural Networks and Fuzzy Logic, Volume 1 p 107 Jan. 1993
Avail: CASI HC A01/MF A03

This paper discusses an application of fuzzy control to an unmanned helicopter. The authors design a fuzzy controller to achieve semi-autonomous flight of a helicopter by giving macroscopic flight commands from the ground. The fuzzy controller proposed in this study consists of two layers: the upper layer for navigation supervising the lower layer and the lower layer for ordinary rule based control. The performance of the fuzzy controller is evaluated in experiments where an industrial helicopter Yamaha R-50 is used. At present an operator can wirelessly control the helicopter through a flight computer with eight commands such as 'hover', 'fly forward', 'turn left', 'stop', etc. Author (revised)

N93-22367*# Sikorsky Aircraft, Stratford, CT. Advanced Research and Design.
FUZZY LOGIC MODE SWITCHING IN HELICOPTERS Abstract Only
PORTER D. SHERMAN and FRANK W. WARBURTON *In* NASA. Johnson Space Center, Proceedings of the Third International Workshop on Neural Networks and Fuzzy Logic, Volume 1 p 108 Jan. 1993
Avail: CASI HC A01/MF A03

The application of fuzzy logic to a wide range of control problems has been gaining momentum internationally, fueled by a concentrated Japanese effort. Advanced Research & Development within the Engineering Department at Sikorsky Aircraft undertook a fuzzy logic research effort designed to evaluate how effective fuzzy logic control might be in relation to helicopter operations. The mode switching module in the advanced flight control portion of Sikorsky's motion based simulator was identified as a good candidate problem because it was simple to understand and contained imprecise (fuzzy) decision criteria. The purpose of the switching module is to aid a helicopter pilot in entering and leaving coordinated turns while in flight. The criteria that determine the transitions between modes are imprecise and depend on the varied ranges of three flight conditions (i.e., simulated parameters): Commanded Rate, Duration, and Roll Attitude. The parameters were given fuzzy ranges and used as input variables to a fuzzy rulebase containing the knowledge of mode switching. The fuzzy control program was integrated into a real time interactive helicopter simulation tool. Optimization of the heading hold and turn coordination was accomplished by interactive pilot simulation

testing of the handling quality performance of the helicopter dynamic model. The fuzzy logic code satisfied all the requirements of this candidate control problem. Author (revised)

N93-22394# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Hubschrauber und Flugzeuge.
COMPUTER AIDED INTEGRATED PRODUCTION PLANNING IN UNIT PRODUCTION, AS REPRESENTED IN AIRCRAFT CONSTRUCTION [COMPUTERGESTUETZTE INTEGRIERTE PRODUKTIONSPLANUNG IN DER EINZELFERTIGUNG. DARGESTELLT AM FLUGZEUGBAU]
WERNER FISCHER Jun. 1990 53 p In GERMAN Presented at PPS, Wandel, Germany, 26-27 Jun. 1990
(MBB-FW-3-S-PUB-0439-A; ETN-93-93440) Avail: CASI HC A04/MF A01

It is shown that the utilization of technical products takes place by fluxes and processes which are similar to biological processes, in connection with information, energy, and material. Avionics and Computer Integrated Manufacturing (CIM) are the most important application fields. The three domains, product internal, product near, and product neutral information processing, used very different processes. Great rationalization and quality improvements are still expected for Computer Aided Software Engineering (CASE). The consequences of integrated information processing are reported. It is concluded that companies have to solve more or less integration tasks, according to the product complexity and the operating cycles. ESA

N93-24655*# San Jose State Univ., CA. Aerospace Engineering.
FLOWFIELD COMPUTER GRAPHICS Final Annual Technical Report, 1 Oct. 1991 - 31 Jan. 1993
RICHARD DESAUTEL 10 May 1993 152 p Original contains color illustrations
(Contract NCC2-430)
(NASA-CR-193029; NAS 1.26:193029) Avail: CASI HC A08/MF A02; 2 functional color pages

The objectives of this research include supporting the Aerothermodynamics Branch's research by developing graphical visualization tools for both the branch's adaptive grid code and flow field ray tracing code. The completed research for the reporting period includes development of a graphical user interface (GUI) and its implementation into the NAS Flowfield Analysis Software Tool kit (FAST), for both the adaptive grid code (SAGE) and the flow field ray tracing code (CISS). Derived from text

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A93-29940
EXPERIMENTAL STUDY ON PROPELLER FENCE FOR EFFICIENCY ENHANCEMENT AND NOISE REDUCTION
XICHANG MAO, HONGMIN LI, and JIEBING WANG (Beijing Univ. of Aeronautics and Astronautics, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 8, no. 1 Jan. 1993 p. 56-58. In Chinese. refs

Three-blades scale-model propellers with and without propeller fence along the chord direction at 88 percent tip blade radius are compared experimentally in the wind tunnel in respect of aerodynamic and acoustic characteristics. Their rotational speeds vary between 1500 rpm to 3000 rpm. Experimental results indicate that, under conditions of identical advance ratio J, the efficiency of the propeller with propeller fence is enhanced 1.9 to about 4.9 percent and its lower noise level is reduced 13 to about 20 dB. It is shown that the propeller fence is one of effective measures to increase efficiency and to decrease noise of propellers. Author

A93-30466* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIGNAL PROCESSING OF AIRCRAFT FLYOVER NOISE
J. J. KELLY (Lockheed Engineering & Sciences Co., Hampton, VA) Journal of Sound and Vibration (ISSN 0022-460X) vol. 160, no. 3 Jan. 22, 1993 p. 485-501. refs
(Contract NAS1-19000)
Copyright

A detailed analysis of signal processing concerns for measuring aircraft flyover noise is presented. Development of a de-Dopplerization scheme for both corrected time history and spectral data is discussed along with an analysis of motion effects on measured spectra. A computer code was written to implement the de-Dopplerization scheme. Input to the code is the aircraft position data and the pressure time histories. To facilitate ensemble averaging, a level uniform flyover is considered in the study, but the code can accept more general flight profiles. The effects of spectral smearing and its removal are discussed. Using test data acquired from an XV-15 tilt-rotor flyover, comparisons are made between the measured and corrected spectra. Frequency shifts are accurately accounted for by the de-Dopplerization procedure. It is shown that by correcting for spherical spreading and Doppler amplitude, along with frequency, can give some idea about noise source directivity. The analysis indicated that smearing increases with frequency and is more severe on approach than recession. Author

A93-31774
EFFECTS OF FUSELAGE BOUNDARY LAYER ON NOISE PROPAGATION FROM ADVANCED PROPELLERS
PETER L. SPENCE (Lockheed Engineering & Sciences Co., Hampton, VA) Journal of Aircraft (ISSN 0021-8669) vol. 29, no. 6 Nov.-Dec. 1992 p. 1005-1011. refs

A computer program has been developed that models refractive and scattering effects on acoustic pressure waves propagating through a boundary layer, encompassing an aircraft's fuselage. The periodic noise source is generated by a propeller and is assumed to be known. The fuselage is represented by an infinitely long cylinder embedded in a longitudinal flow. For a specified boundary-layer velocity profile and thickness, the program calculates the acoustic pressure at the surface of the cylinder, given the incident field at the top of the boundary layer. Numerical experiments illustrate the importance of describing the boundary-layer velocity profile shape and thickness as accurately as possible. Computational results are compared with flight test data measured during the Propfan test assessment (PTA) experiment. Comparisons of theoretical results with the measured data show good agreement. Author

A93-31940
SONIC BOOM FOCAL ZONES FROM TACTICAL AIRCRAFT MANEUVERS
KENNETH J. PLOTKIN (Wyle Labs., Inc., Arlington, VA) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 75-80. AIAA, Aeroacoustics Conference, 13th, Tallahassee, FL, Oct. 22-24, 1990, AIAA Paper 90-4003. Previously cited in issue 02, p. 234, Accession no. A91-12516 refs
(Contract F49642-83-C-0223)
Copyright

A93-31942
MECHANISMS OF TRANSONIC BLADE-VORTEX INTERACTION NOISE
H.-M. LENT, G. E. A. MEIER, K. J. MUELLER, F. OBERMEIER, U. SCHIEVELBUSCH, and O. SCHUERMANN (Max-Planck-Inst. fuer Stroemungsforschung, Goettingen, Germany) Journal of Aircraft (ISSN 0021-8669) vol. 30, no. 1 Jan.-Feb. 1993 p. 88-93. AIAA, Aeroacoustics Conference, 13th, Tallahassee, FL, Oct. 22-24, 1990, AIAA Paper 90-3972. Previously cited in issue

02, p. 231, Accession no. A91-12485 refs

A93-32447
CLASSIFICATION OF ATMOSPHERIC ACOUSTIC SIGNALS FROM FIXED-WING AIRCRAFT
CLAYTON STEWART, VICTOR LARSON (George Mason Univ., Fairfax, VA), and DAVID ZINK (Analytic Sciences Corp., Arlington, VA) *In* Signal processing, sensor fusion, and target recognition; Proceedings of the Meeting, Orlando, FL, Apr. 20-22, 1992 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 136-143. refs

This paper presents analysis on the ability to classify fixed-wing aircraft based on their acoustic signatures. Since only a small amount of data was available, the paper focuses on feature extraction. We analyzed a data set for a single propellor and a single jet aircraft. Both spectral and cepstral analyses were performed on the data. Both nonparametric and parametric methods were used to estimate the power spectrum. For the propellor aircraft, the frequency ratio between spectral lines was found to be a useful feature for classification. The cepstrum of both the propellor and jet aircraft acoustic data were found to contain features related to engine rotation rates. Author

A93-32693
RECENT STATES AND TRENDS OF AMERICAN HELICOPTER NOISE PREDICTION SYSTEM
GUOHUA XU and ZHENG GAO (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956) vol. 25, no. 1 Feb. 1993 p. 75-81. In Chinese. refs

The helicopter noise prediction system ROTONET is described briefly in this paper. The characteristics and prediction capabilities in every phase of ROTONET system are analyzed, and comparisons of flyover noise are emphasized between measured and calculated values for the MD-500E and SA365 N-1 helicopters to explain the validity of the ROTONET system and to evaluate the technology status in the field of helicopter system noise prediction in the USA. Finally, the Phase IV ROTONET System being developed now and the future work for ROTONET are pointed out.
Author (revised)

A93-32915
SPECIALTY FIBER OPTIC SYSTEMS FOR MOBILE PLATFORMS; PROCEEDINGS OF THE MEETING, BOSTON, MA, SEPT. 5, 1991
NORRIS E. LEWIS, ED. (Litton Systems, Inc., Poly-Scientific Div., Blacksburg, VA) and EMERY L. MOORE, ED. (Litton Industries, Inc., Guidance and Control Systems Div., Woodland Hills, CA) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1589) 1991 155 p. For individual items see A93-32916 to A93-32920
(SPIE-1589; ISBN 0-8194-0720-8) Copyright

Consideration is given to a review of the Fiber Optic Control System Integration Program, an optical rotary connector for transfer of data signals from fiber optic sensors, a fluorescence-based fiber optic temperature sensor for aerospace applications, power-by-light flight control, a naval fiber optic system development program, a fiber optic pressure sensor, and the use of fiber optic communications and control for a tethered undersea vehicle. Attention is also given to an algorithm for a novel fiber optic weight-in-motion sensor system, ignition risks of fiber optic systems, optical encoders using pseudo-random-binary-sequence scales, and application of a visible/infrared integrated double detector to obstacle detection in automotive. AIAA

A93-32920
OPTICAL ENCODERS USING PSEUDO RANDOM BINARY SEQUENCE SCALES
J. S. JOHNSTON, A. E. ROMER, and M. S. BEALES (Rosemount, Ltd., Bognor Regis, United Kingdom) *In* Specialty fiber optic systems for mobile platforms; Proceedings of the Meeting, Boston, MA, Sept. 5, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 126-132. refs

Instruments based on a track encoded with a pseudo-random-binary-sequence, a small section of which is imaged onto a line-scan sensor, are described. The digital word image gives the coarse position while the exact location of edges in the image gives the fine position. It is concluded that the use of a coarse scale with post processing of the image permits the design of robust rotary and linear encoders for a wide range of industrial and aircraft environments. AIAA

A93-33434
OPTICAL ANALYSIS OF SEGMENTED AIRCRAFT WINDOWS
MIKE I. JONES (General Dynamics Corp., Fort Worth, TX) and MARK S. JONES (Storz Instrument Co.; McDonnell Aircraft Co., Saint Louis, MO) *In* Tactical infrared systems; Proceedings of the Meeting, Dallas, TX, May 8, 9, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 110-127. refs

Segmented windows for military aircraft introduce several optical effects into airborne electro-optical sensor imagery. A diffraction-based computer code has been written to calculate these effects and predict impacts on installed sensor performance. Experimental validation of the code agrees to within 3 percent. The window segments are seen to effectively divide the sensor pupil into separate optical apertures sharing a common focal plane. Extremely tight optical wedge tolerances are indicated for high-resolution sensors. Performance predictions for various pupil splitting geometries are shown, both for polychromatic incoherent sensor imagery and coherent laser radiation. Effects of varying differential wedge on sensor imagery are shown. Author

A93-33437
OVERPRESSURE PROOF TESTING OF LARGE INFRARED WINDOWS FOR AIRCRAFT APPLICATIONS
CHARLES J. PRUSZYNSKI (CJP Associates, Bixby, OK) *In* Tactical infrared systems; Proceedings of the Meeting, Dallas, TX, May 8, 9, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1991 p. 163-170. refs

Many commonly used infrared window materials, such as zinc sulfide and zinc selenide, are subject to structural failure due to stress-corrosion induced cracking. This failure mechanism is of critical importance in applications in which the window experiences high static pressure loading for prolonged periods in humid atmospheres, conditions typical of airborne optical windows. The most effective means of screening windows against failure due to this mechanism is by use of overpressure proof testing. In this paper, the design of overpressure proof tests for large airborne infrared windows is discussed. The underlying physical phenomena and governing mathematical relationships are presented. A hypothetical proof test design for a large infrared window to be employed in a man-rated aircraft is developed to illustrate the application of the analytical methodology. Practical considerations in the execution of large infrared window overpressure proof tests are also discussed. Author

N93-22673*# Cambridge Acoustical Associates, Inc., MA.
AEROACOUSTIC DIFFRACTION AND DISSIPATION BY A SHORT PROPELLER COWL IN SUBSONIC FLIGHT Final Report
RUDOLPH MARTINEZ Apr. 1993 72 p
(Contract NAS3-26598; RTOP 535-03-10)
(NASA-CR-190801; E-7717; NAS 1.26:190801) Avail: CASI HC A04/MF A01

This report develops and applies an aeroacoustic diffraction theory for a duct, or cowl, placed around modelled sources of propeller noise. The regime of flight speed is high subsonic. The modelled cowl's inner wall contains a liner with axially variable properties. Its exterior is rigid. The analysis replaces both sides with an unsteady lifting surface coupled to a dynamic thickness

problem. The resulting pair of aeroacoustic governing equations for a lined 'ring wing' is valid both for a passive and for an active liner. Their numerical solution yields the effective dipole and monopole distributions of the shrouding system and thereby determines the cowl-diffracted component of the total radiated field. The sample calculations here include a preliminary parametric search for that liner layout which maximizes the cowl's shielding effectiveness. The main conclusion of the study is that a short cowl, passively lined, should provide moderate reductions in propeller noise. Author (revised)

N93-22813*# Eagle Engineering, Inc., Hampton, VA.
FEASIBILITY STUDY ON CONDUCTING OVERFLIGHT MEASUREMENTS OF SHAPED SONIC BOOM SIGNATURES USING THE FIREBEE BQM-34E RPV
DOMENIC J. MAGLIERI, VICTOR E. SOTHCOTT, and THOMAS N. KEEFER, JR. Feb. 1993 66 p
(Contract NAS9-17900; RTOP 537-03-21-01)
(NASA-CR-189715; NAS 1.26:189715) Avail: CASI HC A04/MF A01

A study was performed to determine the feasibility of establishing if a 'shaped' sonic boom signature, experimentally shown in wind tunnel models out to about 10 body lengths, will persist out to representative flight conditions of 200 to 300 body lengths. The study focuses on the use of a relatively large supersonic remotely-piloted and recoverable vehicle. Other simulation methods that may accomplish the objective are also addressed and include the use of nonrecoverable target drones, missiles, full-scale drones, very large wind tunnels, ballistic facilities, whirling-arm techniques, rocket sled tracks, and airplane nose probes. In addition, this report will also present a background on the origin of the feasibility study including a brief review of the equivalent body concept, a listing of the basic sonic boom signature characteristics and requirements, identification of candidate vehicles in terms of desirable features/availability, and vehicle characteristics including geometries, area distributions, and resulting sonic boom signatures. A program is developed that includes wind tunnel sonic boom and force models and tests for both a basic and modified vehicles and full-scale flight tests. Author (revised)

N93-24070*# Sverdrup Technology, Inc., Brook Park, OH.
AN ASYMPTOTIC THEORY OF SUPERSONIC PROPELLER NOISE Final Report
EDMANE ENVIA May 1992 20 p Presented at the 14th Aeroacoustics Conference, Aachen, Germany, 11-14 May 1992; sponsored by DGLR and AIAA Previously announced in IAA as A93-19169
(Contract NAS3-25266; RTOP 535-03-10)
(NASA-CR-191110; E-7723; NAS 1.26:191110) Avail: CASI HC A03/MF A01

A theory for predicting the noise field of supersonic propellers with realistic blade geometries is presented. The theory, which utilizes a large-blade-count approximation, provides an efficient formula for predicting the radiation of sound from all three sources of propeller noise. Comparisons with a full numerical integration indicate that the levels predicted by this formula are quite accurate. Calculations also show that, for high speed propellers, the noise radiated by the Lighthill quadrupole source is rather substantial when compared with the noise radiated by the blade thickness and loading sources. Results from a preliminary application of the theory indicate that the peak noise level generated by a supersonic propeller initially increases with increasing tip helical Mach number, but is eventually reaches a plateau and does not increase further. The predicted trend shows qualitative agreement with the experimental observations. Author

N93-24119# Systems Control Technology, Inc., Arlington, VA.
TILTROTOR AIRCRAFT NOISE: A SUMMARY OF THE PRESENTATIONS AND DISCUSSIONS AT THE 1991 FAA/GEORGIA TECH WORKSHOP Final Report
K. K. AHUJA Jan. 1992 55 p
(Contract DTFA01-87-C-0014)
(AD-A260072; A8924-1; DOT/FAA/RD-91/23) Avail: CASI HC A04/MF A01

Georgia Institute of Technology hosted a workshop in Atlanta on 28-29 Mar. 1991 on the noise problems associated with tiltrotors. The workshop had two major objectives: (1) to review the status of research and development in predicting and reducing tiltrotor noise; and (2) to identify key technical and operational issues and methods to address them. The second objective had both near term and far term implications. In the near term, the goal is to arrive at a level of technical credibility that can support decisions to develop urban and inner city markets. The long term goal is to target resources and actions which will lead to tiltrotor noise abatement and effective control. The opening session consisted of an overview and a discussion of the physics of tiltrotor noise mechanisms. A review of the available experiment data followed. A discourse on potential flight operational procedures to minimize noise impacts, and a general presentation of industry and government perspectives concluded the workshop. Subsequent sessions were available for participants to present observations on and experiences with the XV-15 and V-22. Operational experiences included flight tests, wind tunnel tests, and other simulations. Experiences with computational fluid dynamics codes, small-scale model testing, and other related research were shared. A summary of the presentations and discussions are provided. Author (revised)

N93-24572# Harris, Miller, Miller and Hanson, Inc., Lexington, MA.
AIRCRAFT OVERFLIGHT STUDY: EFFECT OF AIRCRAFT ALTITUDE UPON SOUND LEVELS AT THE GROUND
GRANT S. ANDERSON and RICHARD D. HORONJEFF Mar. 1992 80 p Sponsored by National Park Service, Denver, CO
(Contract NPS-DSC-CX-2000-0-0025)
(PB93-144194; HMMH-290940.02; NPOA-91-4) Avail: CASI HC A05/MF A01

The report summarizes that literature review, discussing sound divergence, atmospheric absorption, attenuation due to intervening hills and heavily wooded areas, soft-ground attenuation, and the acoustical descriptors that are of potential concern to the Park Service as the aircraft flies by the area. Finally, the report concludes with a summary of the effect of aircraft altitude upon sound levels on the ground, taking all these factors into account. Included in the summary is a discussion of the potential acoustical effectiveness of using altitude as a mitigation measure for any adverse effects of aircraft sound within the National Park System. GRA

N93-24649# Harris, Miller, Miller and Hanson, Inc., Lexington, MA.
AIRCRAFT OVERFLIGHT STUDY RECOMMENDED PLAN: DETAILED SAMPLING, DATA COLLECTION AND DATA ANALYSIS PLANS FOR THE VISITOR SURVEY AND THE DOSE-RESPONSE SURVEY
ROBERT M. BAUMGARTNER, CARY MCDONALD, RONALD IACHAN, GRANT S. ANDERSON, RICHARD D. HORONJEFF, CHRISTOPHER W. MENGE, and NICHOLAS P. MILLER Apr. 1992 145 p Sponsored by National Park Service Prepared in cooperation with HBRS, Inc., Madison, WI, and Research Triangle Inst., Research Triangle Park, NC
(Contract NPS-DSC-CX-2000-0-0025)
(PB93-144186; HMMH-290940.08; NPOA-91-6) Avail: CASI HC A07/MF A02

The report describes the recommended study design for an National Park Service (NPS) area visitor survey and a dose-response study to be conducted as part of the research for the NPS Aircraft Overflight Study. The NPS Aircraft Overflight Study is based upon the directives for research contained Public Law 100-91. That document states that the study should: (1) determine the proper minimum altitude for aircraft flying over park units; (2) identify any problems associated with aircraft overflights of park units; (3) provide information regarding the types of overflights which may impact park units; (4) distinguish between impacts

caused by different types of aircraft activity; and (5) identify park system units and portions where the most serious impacts exist. GRA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A93-30092
ANALYSIS AND DEVELOPMENTS OF THE EC AIRCRAFT NOISE DIRECTIVES
CHRISTOPHE REYMOND Air & Space Law (ISSN 0927-3379) vol. 18, no. 1 Feb. 1993 p. 2-15. refs
Copyright

In all matters bearing on aircraft noise pollution, the EC has concentrated on the control of noise at its source through the adoption of ICAO standards. Attention is presently given to the provisions of the 1989 and 1992 Aircraft Noise Directives of the European Commission. Recommendations are presented for a progressive EC noise-abatement policy offering incentives for noise emission reductions through technological progress; this could encompass levies on noise sources and tax relief for the quietest installations. O.C.

A93-30094
AIRCRAFT USE, REGISTRATION AND LEASING IN THE EC
ROBERT RICKETTS and JOHN BALFOUR (Frere Cholmeley, London, United Kingdom; Frere Cholmeley, Brussels, Belgium) Air & Space Law (ISSN 0927-3379) vol. 18, no. 1 Feb. 1993 p. 25-28.
Copyright

The 'third package' of air transport liberalization legislation, which was adopted by the EC on June 22, 1992, deals with the licensing of air carriers, access, and fares within the EC. Attention is presently given to complex provisions within the regulation on the licensing of air carriers regarding the use, registration, and leasing of aircraft; it is noted that these provisions may create 'registers of convenience' within the EC. O.C.

A93-30941#
DESIGN TO COST WITH PRICE H
ROBERT R. SOLVERSON (Hughes Aircraft Co., El Segundo, CA) Feb. 1993 15 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1030) Copyright

A graphical arithmetical method is displayed which enables an engineer or designer to relate the theoretical first-piece cost of his design to four other design descriptors: technology, weight, drawing count, and MTBF. Since Design-to-Unit-Production-Cost, DTUPC, can be written as a product of the theoretical first-piece cost and a multipler which handles all the other pertinent factors of recurring production, the engineer or designer can scale his charts to the DTUPC Goal at whatever cost level he desires. Two graphs, or design aids can be created by running the PRICE H model in the design descriptor domain of interest. Two charts are necessary if the item includes both electronics and non-electronics. Several key factors affecting recurring production are discussed. Methods for relating an individual's MTBF and drawing count experience to the PRICE H's regressions are treated. An illustrative problem involving the design of an airborne signal processor for a light weight helicopter is included. The example shows the need for the engineer/designer's own 'rules of thumb' or other methodology from the PRICE models to make the most of the design aid charts. Author

A93-30970#
AEROSPACE FUNDAMENTALS AND DESIGN IN SIX SEMESTER CREDITS - A BARE BONES APPROACH
M. C. SMITH (Michigan State Univ., East Lansing) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1078) Copyright

The paper proposes a bare-bone approach to undergraduate technical and design courses constrained within six semester credits, which would be an undergraduate mechanical-engineering sequence to the fundamentals of aerospace technology and design. The studies proposed include thermo-fluids review and atmospheric properties; basic aerodynamics; aerodynamics of airfoils, wings, and other shapes; fundamentals of propulsion in aerospace; vehicle performance and analysis; and static stability, dynamic stability, and control. I.S.

A93-30971#
APPLIED STABILITY AND CONTROL IN AERONAUTICS AND ASTRONAUTICS - DESIGN AND SCIENCE
CONRAD F. NEWBERRY (U.S. Naval Postgraduate School, Monterey, CA) and WALLACE T. FOWLER (Texas Univ., Austin) Feb. 1993 14 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1079)

This paper provides some suggestions which can be used to improve the teaching of design within both aeronautics and astronautics stability and control courses. Attention is given to the apparent confusion between the definitions, roles, and concepts of science, engineering, and design as well as to the linkage of design capability and the apparent declining competitiveness of the United States aerospace industry in world markets. It is expected that an increase in the design content of engineering science courses will improve student capabilities. It is shown that this increase in curriculum design content can be achieved with almost no reduction in class time devoted to engineering science topics. Author

A93-30995*# National Aeronautics and Space Administration, Washington, DC.
THE CAL POLY AIRCRAFT DESIGN PROGRAM
DORAL R. SANDLIN and ROBERT VAN'T RIET (California Polytechnic State Univ., San Luis Obispo) Feb. 1993 11 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 Research supported by, NASA and Universities Space Research Association refs
(AIAA PAPER 93-1111) Copyright

Discussed is the aircraft design program at Cal Poly, SLO. The history of the program and the impact of the NASA/USRA ADP are presented. Examples of student design accomplishments are included. Questions on how the aircraft design education process can be improved are postulated. Author

A93-31049#
RELATING ECONOMICS TO ROTORCRAFT DESIGN PARAMETERS THROUGH A CRITERION FUNCTION
DANIEL P. SCHRAGE (Georgia Inst. of Technology, Atlanta) Feb. 1993 12 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1180) Copyright

It is no secret that economics will be the key for rotorcraft, both civil and military, fulfilling their potential as well accepted transportation and weapon systems. As more focus is placed on quality and minimizing the loss to society after the product is delivered, understanding and addressing the relationships between economics and rotorcraft design parameters will be essential. While terms such as concurrent engineering and integrated product and process development are used to describe the environment to achieve better, higher quality products in reduced time, the concurrent design of the product and process (both manufacturing and support) is the essential enabler. Concurrent design to address quality improvements and reduced cycle time requires metrics relating economics to rotorcraft design parameters. While

relationships exist between economics and rotorcraft design parameters they are not well understood by the cross section of operators, manufacturers, and government agencies involved in the design, development, qualification and certification, production, and support of rotorcraft. This paper will attempt to shed some light on these relationships through the use of a criterion function. The criterion function can be used as a formal objective function, addressing both product and process considerations, and can provide the missing linkage between economics and rotorcraft design parameters. Author

A93-31050#
DESIGN-TO-LIFE-CYCLE-COST IN AEROSPACE
HENRY APGAR (Management Consulting & Research, Inc., Advanced Technologies Div., Oxnard, CA) Feb. 1993 10 p. AIAA, AHS, and ASEE, Aerospace Design Conference, Irvine, CA, Feb. 16-19, 1993 refs
(AIAA PAPER 93-1181) Copyright

This paper describes the application of Design-to-Cost (DTC) principles in a total life cycle cost (LCC) environment for aerospace products in a process known as Design-to-Life-Cycle-Cost (DTLCC). This description encompasses responsibilities of the government as well as those of aerospace contractors. DTLCC is an especially effective technique in a down-sizing market when limited labor and material resources must assume greater responsibilities for cost management and cost control. Program survival depends on our success in implementing the DTLCC principles described here. This paper offers useful advice in assigning responsibilities, organizing for effectiveness, and creating the often-inadequate documentation. Experience for this paper was gained by the author's employer through numerous consulting assignments to establish, implement, and evaluate DTLCC programs for major aerospace organizations. Author

A93-31546
TECHNOLOGY TRANSFER - THE KEY TO SUCCESSFUL SPACE ENGINEERING EDUCATION
L. S. FLETCHER and R. H. PAGE (Texas A & M Univ., College Station) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 2 Feb. 1993 p. 141-146. Previously cited in issue 03, p. 435, Accession no. A91-14175 refs
Copyright

A93-32180
DEVELOPMENT OF CAD DATA BASES FOR THE HELICOPTER ROTOR BLADE [SOZDANIE BANKOV DANNYKH SAPR LOPASTI NESUSHCHEGO VINTA VERTOLETA]
O. D. POTAPOVA and D. D. SKULKOV *In* Problems in the design of helicopter rotors Moscow Izdatel'stvo Moskovskogo Aviatsionnogo Instituta 1991 p. 56-60. In Russian.
Copyright

The general requirements and principles that have to be considered in developing a data base for the computer-aided design of helicopter rotor blades are briefly reviewed. In particular, attention is given to the general structure of a relational data base, the principal elements of the rotor CAD data base, and the use of the structured query language. The discussion also covers the structure of the data base archive, examples of libraries incorporated in the archive, and implementation of the man-machine interaction. AIAA

N93-23424# Technical Research Centre of Finland, Otaniemi.
ANNUAL BIBLIOGRAPHY, 1989 [TEKNILLINEN KORKEAKOULU VUOSIBIBLIOGRAFIA 1989]
1990 157 p In ENGLISH and FINNISH
(ISSN 0788-9259)
(ISBN-951-22-0488-6; ETN-93-93690) Avail: CASI HC A08/MF A02

The publications by departments and institutes at the Helsinki University of Technology in 1989 are listed as part of the annual report. The authors themselves are responsible for the bibliographical data of the publications. The material is arranged under facilities, departments, and institutes. The bibliography also includes an index by author and keyword. ESA

N93-23462# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
COMPARISON OF FOUR-CURSOR BUTTONS VERSUS JOYSTICK TO ACCESS COMPUTERIZED TECHNICAL INFORMATION FROM AN INTEGRATED MAINTENANCE INFORMATION SYSTEM M.S. Thesis
GERALD E. STREFF and ROBERT H. GUNDEL Sep. 1992 119 p
(AD-A259967; AFIT/GLM/LSY-92S-20) Avail: CASI HC A06/MF A02

The purpose of this thesis was to evaluate the use of four-cursor buttons versus a joystick device to present technical order information on a portable maintenance aid computer for aircraft technicians in a maintenance environment. Studies to date have verified the superiority of computer-presented technical orders when compared to current paper-based systems; this research investigated the effectiveness of these computer-based systems when technicians used a joystick or four-cursor button to display desired technical information. A comparison was made as to technician performance using a portable maintenance aid at the 4950th Test Wing, WPAFB OH. A total of thirty-two maintenance technicians accessed and displayed technical information using a joystick device and the four-cursor keys. Results indicated no statistically significant difference in the performance of maintenance technicians when using either access device in a controlled environment. The major conclusion was that either access device may be a viable answer for use in the flight line environment. The chief recommendation is that further studies be performed using a different joystick device and computer software that supports the eight joystick functions. GRA

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GENERAL

N93-23115# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
ANNUAL PROGRESS REPORT, 1990-1991
1992 121 p
(CTN-93-60695) Avail: CASI HC A06/MF A02

The activities of the University of Toronto Institute for Aerospace Studies are reviewed for 1990-1991. After presenting the biographies of the Institute's academic staff, the facilities available for experimental research are briefly described, including the Aeroacoustics Laboratory, air cushion test facilities, the flexible spacecraft simulator, shock tubes, wind tunnel, and other laboratories. Research projects are then described in the areas of flight mechanics and simulation, air cushion technology, low-speed aerodynamics, nonstationary flows and shock waves, nonstationary gas dynamics, computational fluid dynamics, aeroacoustics, combustion, propulsion, hypersonic aerodynamics, structural mechanics and advanced composite materials, materials processing in space, space robotics, space dynamics and control, applied mass spectroscopy, fusion energy, fiber optic sensors, and smart structures. CISTI

N93-24095*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INNOVATION: KEY TO THE FUTURE Annual Research and Technology Report, 1992
Dec. 1992 267 p
(NASA-TM-103599; NAS 1.15:103599) Avail: CASI HC A12/MF A03

The NASA Marshall Space Flight Center Annual Report is presented. A description of research and development projects is

included. Topics covered include: space science; space systems; transportation systems; astronomy and astrophysics; earth sciences; solar terrestrial physics; microgravity science; diagnostic and inspection system; information, electronic, and optical systems; materials and manufacturing; propulsion; and structures and dynamics. CASI

N93-24652# Institute for Aerospace Research, Ottawa (Ontario). Structures and Materials Lab.

RESEARCH PROJECTS Progress Report, 1990-1991

W. WALLACE 1 Jul. 1992 104 p

(NRC-LTR-ST-1883; CTN-93-60704) Avail: CASI HC A06/MF A02

The Structures and Materials Laboratory (SML) is one of four laboratories of the Institute of Aerospace Research of Canada's National Research Council. The SML is concerned with research and development on matters affecting the structural design, strength, stability, durability, and structural integrity of aircraft, engines, and space structures. After an overview of the organizational structure of the SML and its interactions with external organizations, a synopsis is provided of each of the research projects that were active in the SML during 1990 and 1991. Reports and publications resulting from each of the projects are listed, and illustrations and figures are included for some of the projects. Projects are described under the following programs: aerospace structures, structural dynamics and acoustics; aerospace materials and engineering physics; and structures facilities, services and administration. Author (CISTI)

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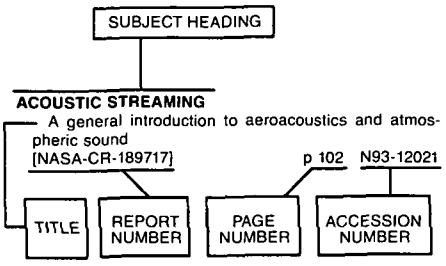

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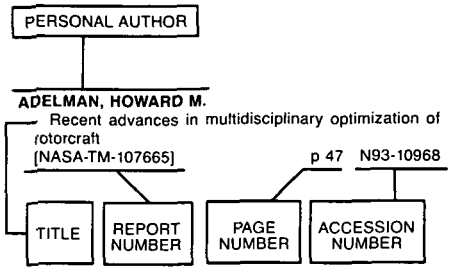

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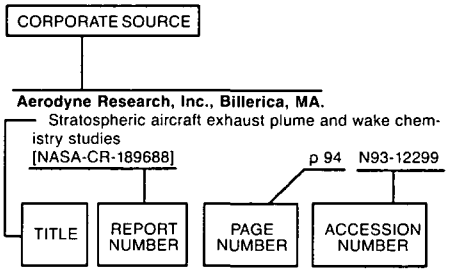

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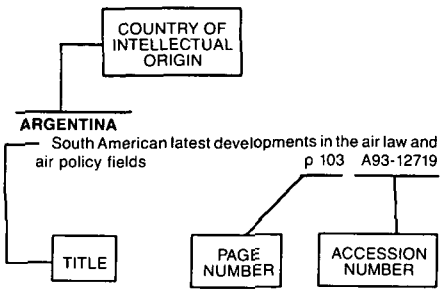

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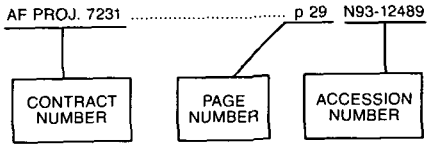

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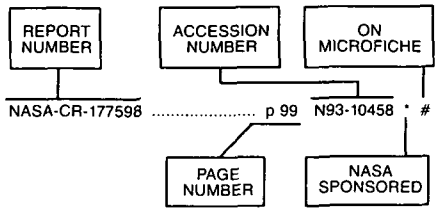

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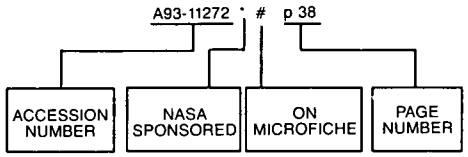

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